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**Analysis of the effect of historical cultural
changes relative to the development of
affordability excursions to existing parametric
cost models.**

AD-A200 744

**Final Report
September 30, 1988**

**Prepared for:
Cost Analysis Office
U.S. Army Strategic Defense Command
Huntsville, AL 35807**

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Dedication

This report is dedicated to the U.S. Army Strategic Defense Command professionals that face the challenge daily of reshaping our "*business as usual*" ergonculture to improve productivity.

A more productive, better managed government with a work force that delivers excellence—this is an important part of the legacy I plan to leave to future Presidents and the America they serve.

Ronald Reagan
February 18, 1988

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Preface

Our cultural heritage is often taken for granted if, in fact, it is thought about at all. Modern managers strive daily to influence human behavior and yet many have little appreciation for our cultural heritage and the manner in which cultural forces influence humans and their responses to their environments.

This report concerns culture and its influence on human behavior—human behavior as directly related to productivity. The thrust of the research was historical in order to establish a frame of reference for our present environment and to plot the major milestones that marked its course. The true significance of the research is found, however, not in the weaving of the cultural fabric, but in the application of the lessons learned from the weavers. With this focus in mind, this report is intended as the qualitative baseline from which quantitative cost estimating relationships for military defense knowledge work may be derived.

The author is deeply indebted to a number of individuals for their assistance with this research ranging from providing cultural and productivity baseline data to sharing their views and insights on the effects of cultural changes on productivity. Specific acknowledgement is made of the valued, individual contributions of the following:

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Mr. Dick Power, Department of Defense
Dr. Saul Pleeter, Department of Defense
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In addition to the material collected specifically for this project, the author used data and material from earlier independent research activity related to the evolution of management thought and from a graduate level management history course developed by the author. As a result, some of the material appearing in this report is copyrighted by the author and is provided for Federal Government use only in conjunction with the affordability excursions to existing parametric cost models activity.

William C. Wall, Jr., Ph.D.
Huntsville, Alabama
September 30, 1988

Executive Summary

Productivity—A Defense Priority.

Fy 89 DOD Productivity
Improvement Plan

This report searches pertinent historical corridors for clues to the effects of historical cultural changes on present day knowledge worker productivity. The search is chronologic and divided into six periods:

- Historic Era
- Preindustrialization Era
- Industrialization Era
- The Age of Efficiency
- The Sociologic Era
- The Age of Systems

The search finds that humankind's quest for order, knowledge, and happiness is indelibly intertwined with its pursuit of mastery over matter and environment, and greater productivity.

The macro U.S. ergonculture effects that follow are based directly on the research associated with this project and apply to the U.S. cultural base. They are not founded on any particular theory of macro-history nor are they ordered in any sense of ordinal importance:

- Culture can, will, and does change and is doing so at an increasing rate.
- Increasingly our culture follows a fairly rigid pattern of education, working, and retirement.
- The work ethic reconciles the antithesis between material happiness and religious worth.
- The economic element of our ergonculture has moved from an agrarian-based to a capitalistic-based foundation with emphasis on the service sector and a decline on the manufacturing sector.
- Our technology base is gaining mastery of matter and environment at an increasing rate.
- We hold dear the new state of human liberty proclaimed by the Declaration of Independence.
- Women are playing an increasingly larger and more important role in ergonculture development.
- Military offensive and defensive capabilities are increasing at an increasing rate.
- There is an increase in literacy and continuing education.
- Affluence and leisure time are increasing.
- Heroes are critical.

- We are moving increasingly from a *revealed truth* base to a reason-based foundation.
- Political power is increasingly centralized and concentrated.
- Information processing is playing an increasingly important role in development of our ergonculture at an increasing rate.
- U.S. culture is becoming more homogeneous while at the same time fostering diversity as an explicit value.
- The entrepreneurial spirit is on the ascendancy.

At the bottom line, this research concludes that the key to increased white-collar productivity is in the hands of management. Management must motivate employees to willingly share an increasingly larger portion of discretionary output that they now generally withhold. A management framework for action includes:

- Establish clear vision of mission.
- Develop a service focus.
- Define expectations.
- Provide the tools, resources, and environment.
- Challenge employees.
- Link rewards with performance.
- Make it happen.

The ball is in management's court.

Chapter 1

Introduction

The past must not be buried but used as a foundation and guide for the footprints which will be made in the future.

Daniel A. Wren

Today's managers are faced with an unprecedented rate of technological change, with a new generation work force that demands—and perhaps properly so—greater industrial democracy, and with increasing competition for scarce resources. As a result, today's managers must steadily improve productivity in order to do more with less while retaining or preferably improving quality of service or product. Public sector managers, in particular, have been challenged by the President in Executive Order 12552, dated February 25, 1986 to ". . . improve the quality and timeliness of service to the public, and to achieve a 20 percent productivity increase in appropriate functions by 1992."

Purpose and Scope

The purpose of this research report is to document the results of an analysis of the effects of historical cultural changes on present-day knowledge worker productivity. Because knowledge work and knowledge workers are primarily a product of the latter portion of the 20th century, the historical trace must, of necessity, build on a foundation of manufacturing and manufacturing-related productivity prior to this century. As knowledge work became recognized for what it is, so did concerns for knowledge worker productivity. We find, therefore, that literature addressing knowledge worker productivity begins to appear in magnitude only in the last two decades.

The research also focuses on public sector concerns, where possible, because the primary utility of the report rests in its application to public sector projects. Within the public sector, the emphasis is centered on Department of Defense (DOD) and DOD-related activities in order to provide the best possible qualitative foundation for quantitative cost estimating relationships.

Research Methodology

In order to approach this task effectively, it was necessary to subdivide the total effort into comfortable elements of meaningful dimensions. Because of the macro-historical perspective of this research, a chronological examination was

chosen as the most meaningful and most effective method of presenting the developed data. Through this means, the reader will be able to visualize serially the big picture of our cultural heritage as it unfolds panel by panel from ancient times.

Periodization in historical writing is a fundamental question, but the selection of major milestones to differentiate historical periods was driven by the technical flavor of the research. The introduction of writing was selected as the starting milestone because it is used by scholars as the milestone separating the prehistoric from the historic era. Additionally, it is only when humankind began to leave written records behind that we are able to form reasonably conclusive ideas about their behavior, their values, their beliefs, and their aspirations.

The next milestone selected was the Renaissance because it marked the end of the "Dark Ages"; a period that saw little cultural advancement and that stifled human progress. The period between the first milestone and this second is referred to as the "Historic" period and covers a timespan of slightly less than 5,000 years (3500 B.C. to approximately mid-fourteenth century).

The third milestone—The Industrial Revolution—was an easy one to select. It marked the shift from an agrarian to an industrialized era and was the trigger for concern with the processes of manufacturing and productivity. The movement opened in Great Britain and has been labeled as the period of change from the "Age of Tools" to the "Age of Machines" and is characterized by the wide-spread substitution of prime mover machine power for natural, animal, and human power. The period between the Renaissance and The Industrial Revolution is labeled "Preindustrialization" and covers a timespan of approximately 400 years (1350 to 1750).

The fourth milestone was the advent of Frederick Taylor's concept of industrial management that sought to apply scientific fact-finding methodologies to determine the best way to perform tasks. Named "Scientific Management" in 1910 by Boston lawyer Louis Brandeis, the movement ushered in a new efficiency craze that stressed discipline, output to input relationships, a "mental revolution" where worker's interests and employer's interests were congruent, and a search for laws of management. The period between the Industrial Revolution and the Scientific Management milestones is labeled "Industrialization" and covers a timespan of approximately 150 years (1750 to 1900).

Human Relations is the label applied to the fifth milestone. It was selected because it marks the early beginnings of the emerging concentration on behavior of people in organizations. The most notable single event that occurred at this milestone was the productivity experiments conducted at The Hawthorne Works of Western Electric from 1924 to 1932. Out of these experiments emerged a new philosophy of human behavior in industrial settings that sought to offset the overemphasis on the technical process of manufacturing by concentrating on the behavioral process. The period between the fourth and fifth milestones covers a timespan of approximately 25 years (1900 to 1925) and is labeled "Efficiency".

The sixth and final milestone is the "Automation Revolution" and reflects the large-scale introduction of automation and electronic data processing into the mainstream of our working environment. Electronic data processing brought with it the ability to substitute machine control for human control in manufacturing processes, to perform complex calculations with a speed and accuracy not formerly possible, and set the stage for the introduction of artificially intelligent systems and robotics. The period between the Human Relations milestone and the Automation Revolution milestone has been labeled "Sociologic," and covers a period of approximately 35 years (1925 to 1960). The period following the Automation Revolution is labeled "Systems" and carries to present day.

Figure 1-1 depicts the study timeline just discussed. While the figure depicts the selected milestones as typical "point events," it is obvious that these study milestones reflect a degree of license on the author's part. None of the milestones occurred at precise points in time nor did they even have specific beginning and ending nodes. Rather, each period overlapped, both with its predecessor and its successor, and the milestones used to separate them reflect a blending of technology, social, economic, and political movements and changes occurring over time.

Background

The historical evolution of the cost parameter as a management tool for decision making, planning, and control extends over a period of years. The main phases of the evolution may be labeled in terms of the major cost focus that marked each period in the evolution as follows:

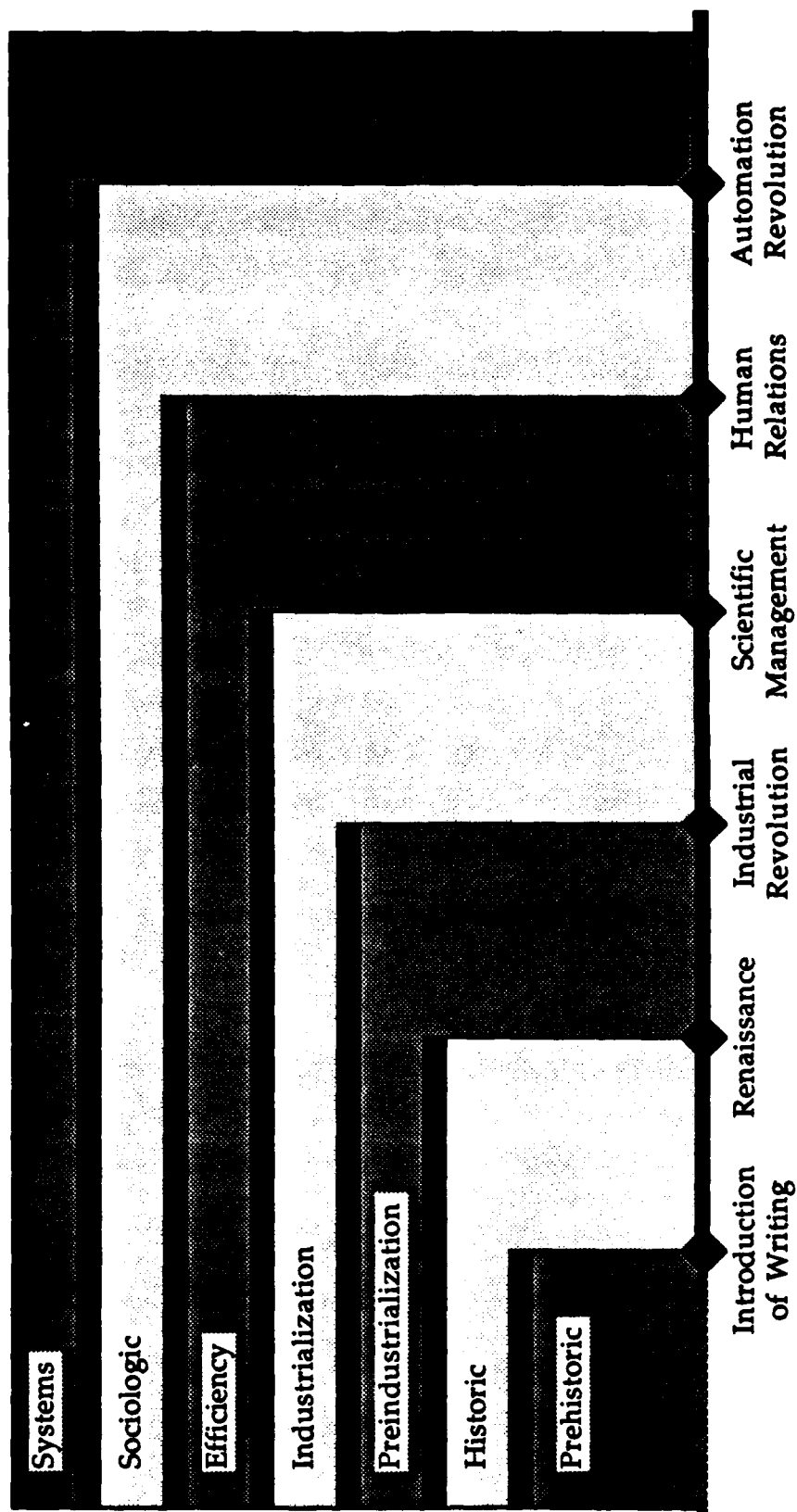
- Budget concept
- Total package concept
- Systems analysis concept

It should be noted that all these concepts are valid and each built upon its predecessor and extended the horizons and dimensions of the earlier concept. In short, each new concept broadened the scope of interest and extended the boundaries of capability of project cost estimating.

The budget concept was consistent with the DOD budget approach wherein a budget ceiling was established consistent with the overall international situation and our national economic and fiscal policy. The ceiling was allocated to each department which would, in turn, allocate its own ceiling among its functions, units, and department activities. Additional requests, that could not be accommodated within the ceiling, would be submitted in addendum budgets. Individual project budgets were developed by project managers to cover their budget only, without any thought to total program costs or total costs of ownership.

The total package concept was introduced in the 1960s as an instrumentality of then DOD Secretary McNamara's new and innovative planning, programming,

Figure 1-1 Study Timeline



Mankind's quest for order, knowledge, and happiness, is indelibly intertwined with his pursuit of greater productivity and the acceleration of technology growth.

budgeting system (PPBS). It embodied a realization that the cost of development and production of military weapon systems was not the total cost involved and that, as later cost data accumulations would determine, the cost of operation and support of military weapon systems amounts to, on average, 60 percent of the total cost of ownership of military systems. In this period, military cost analysts found themselves analyzing standard costs of operation, and new techniques of bookkeeping called "cost accounting" were employed. Military planners began to be concerned with operation and support elements such as cost of real estate, people costs, and supply and maintenance costs. The author remembers vividly in the early 1960s being concerned with the determination of costs for the acquisition, training, use, care, and retirement of military sentry dogs for an emerging system that grew into today's PATRIOT Air Defense System.

It was also during this timeframe that the McNamara analysts introduced the parametric estimating method for estimating the order of magnitude costs of emerging weapon systems. These parametric estimates were used both as early planning figures and for monitoring systems costs. These estimates were referred to as Independent Parametric Cost Estimates (IPCEs) and from this methodological base, the cost analysis process sprang forth in the DOD.

The systems analysis concept emerged in the DOD as a cost method as we began to explore weapon systems not in terms of what could be done, but rather in terms of what should be done. We began to explore alternative means for satisfying requirements and we needed methods for examining problems of choice by examining a full range of possible means of achieving desired military objectives. We began to perform trade-off analyses in which we sought to select the best solution in a fixed cost environment or we sought the least costly solution while holding system performance fixed. David Novick has stated that "more resources are wasted doing the wrong thing efficiently than will ever be used doing the right thing inefficiently." The systems analysis process enhances our ability to decide what the *right thing* is and do it quantitatively.

Parametric cost estimating is an aid to the systems analysis process. It is an estimating method that focuses on the relationship between an explanatory variable characteristic and the cost of the item or service. The variable characteristic can be a hardware performance variable such as power output, thrust, speed, or range, or a configuration variable such as number of antenna radiating elements, weight, volume, or aircraft radar cross-section. The explanatory variable may also be a characteristic relevant to the development process as derived from actual experience on similar program or experiments. Service-related activities such as design or development engineering activity are frequently ratioed as percentages of planned project hardware costs.

The cost estimating relationship or CER that captures that relationship is typically expressed as a mathematical formula. In this manner, the cost estimator may estimate the cost of an item or service with a variable value different from those currently available, but as an understood function of current values. CERs

must be used with understanding for the accuracy of the calculated value diminishes the further the value of the variable being calculated moves from the values used to develop the CER.

Over the past 20 years, the USASDC Cost Analysis Office has developed a comprehensive data base from actual data developed on Army, Navy, and Air Force missile and rocket programs, NASA space programs; and their own actual cost data from the SAFEGUARD and later programs to compile the definitive cost data base for DOD strategic defense missile systems. As a result, the data base is kept current and reflects latest actual cost experience.

Under scrutiny, however, are the ratioed service-related activities that have retained the same relationships to hardware costs for several years. At question is why these services in the knowledge work arena have not reflected improved productivity as a function of learning curve experience, improved techniques and planning, and perhaps cultural changes—either actual or planned. It was this question and the search for an answer that gave rise to this research.

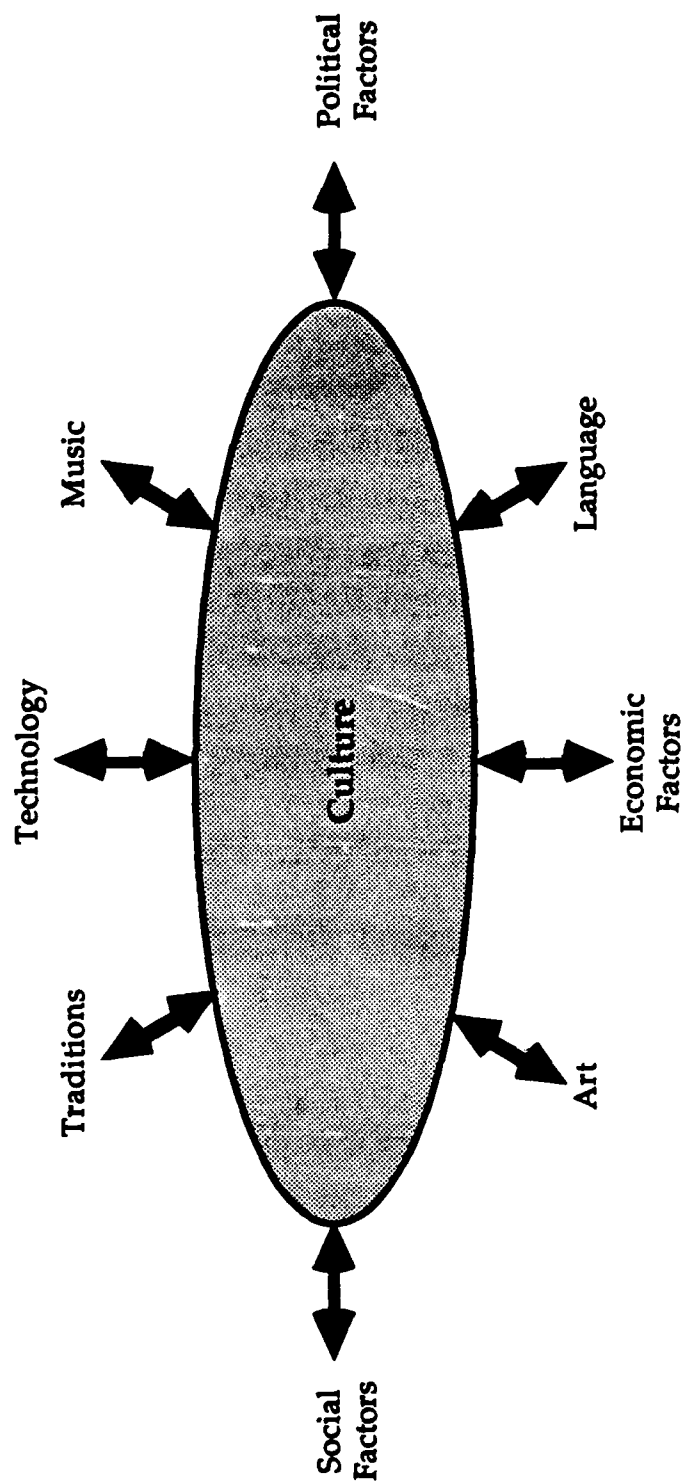
Cultural Framework

With culture and cultural heritage at the heart of this research activity, it is appropriate to attempt at least a notional definition. The purpose in doing so is not to unduly limit the scope and depth of the research, but rather to establish the broad clarifying framework that serves both as the tolerance envelope for the research activity and as the central point of reference for this report.

As Figure 1-2 demonstrates, the term *culture* encompasses a broad range of human outputs and Figure 1-2 is by no means encyclopedic. As the figure suggests by its 2-headed arrows, our culture is both influenced by and directly influences the very outputs that form it. The process is iterative and as human outputs influence our culture, it changes over time and, in turn, causes changes to the products of human labor. Our proactive and responsive integration with and adaptation to our exogenous and endogenous environments change as those environments change. As human beings, we tend to accept and perpetuate those assumptions and patterns that work well enough to demonstrate utility. Similarly, we tend to reject and discard those that demonstrate less than desirable utility. Thus, from a systems perspective, culture is both an input to and an output with the products of our human endeavors.

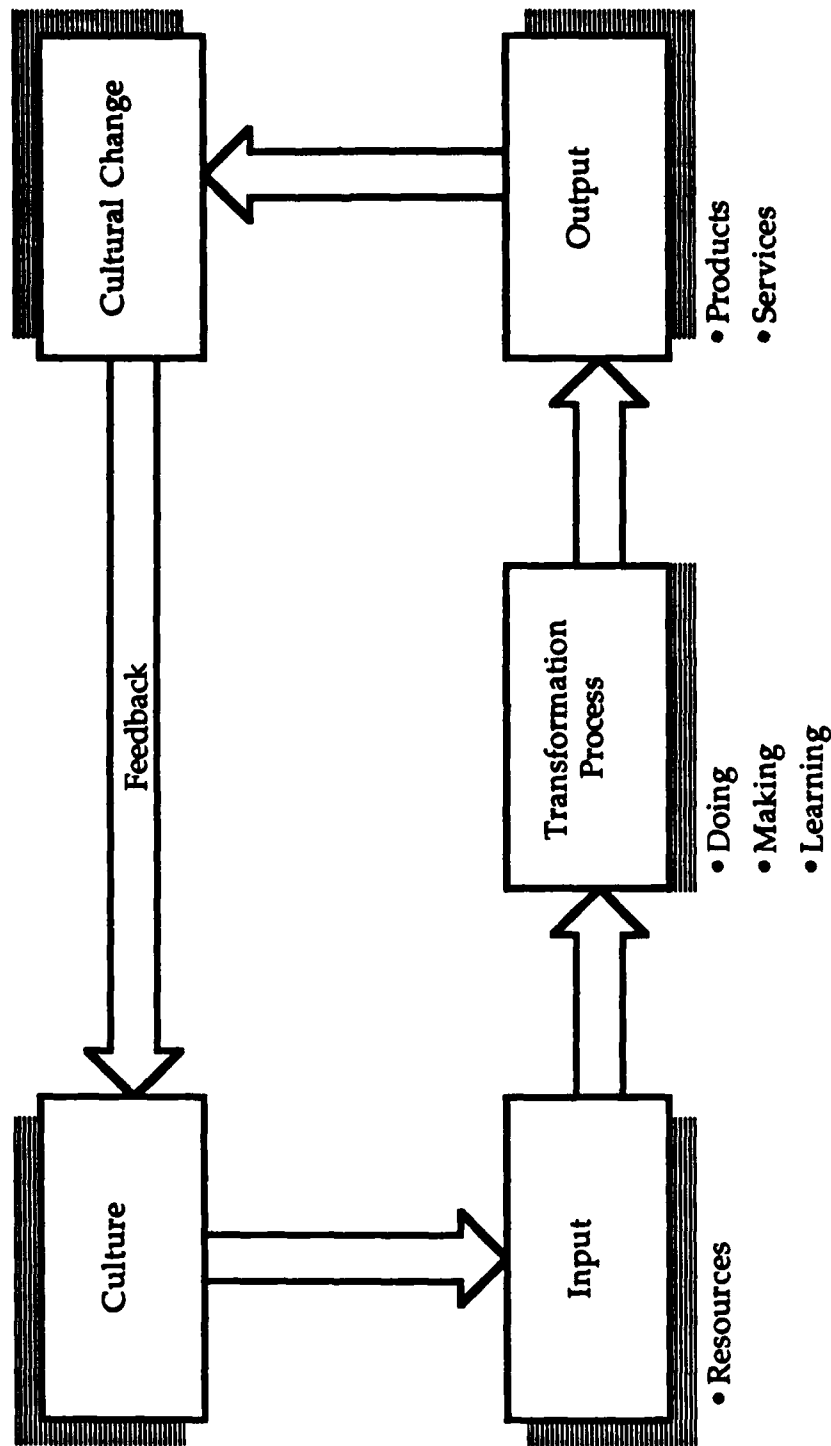
The systems model of evolving cultural change is depicted graphically at Figure 1-3. As the figure suggests, the change process is closed-loop, iterative, and depends upon people for enactment and for information transmission within the loop. Culture and cultural change are transmitted by a process called socialization. While the socialization process may be quite similar from one culture to another, the cultures themselves may be quite different.

Figure 1-2 Representative Cultural Elements



Culture is the totality of all outputs of human capacity — it is influenced by these outputs and is itself a casual factor of change in them.

Figure 1-3 Evolutionary Cultural Change Process



Cultural changes are the result of the voluntary acts of humankind rather than the instinctive and result in fundamental changes in human reaction to stimuli.

The research is confined to those aspects of culture and cultural change that most affect and are affected by knowledge worker productivity concerns in defense, space, and related activities. As a consequence, such culturally affected and affecting factors as language, art forms, superstitions, and dress are omitted as direct areas of concern.

In addition to focusing on specific cultural factors, the research focuses on a specific cultural level within a hierarchic stratification of cultures. Cultures may be stratified in several ways. One method that stratifies cultures by hierarchic arrangement is depicted at Figure 1-4. While not necessarily all inclusive, it reflects a systemic focus defining broad interrelationships among co-existing and concurrent cultures. The hierarchy is depicted in typical descending order. There is, however, some evidence that cultural phenomena develop in ascending order and may skip hierarchic levels in their development. As Figure 1-4 suggests, the levels are interdependent and influence may travel down or up in the hierarchy.

The cultural level of interest in this research is at the functional level because it is high enough to be of value in formulating recommendations and low enough to be of direct application to the research thrust of knowledge worker productivity.

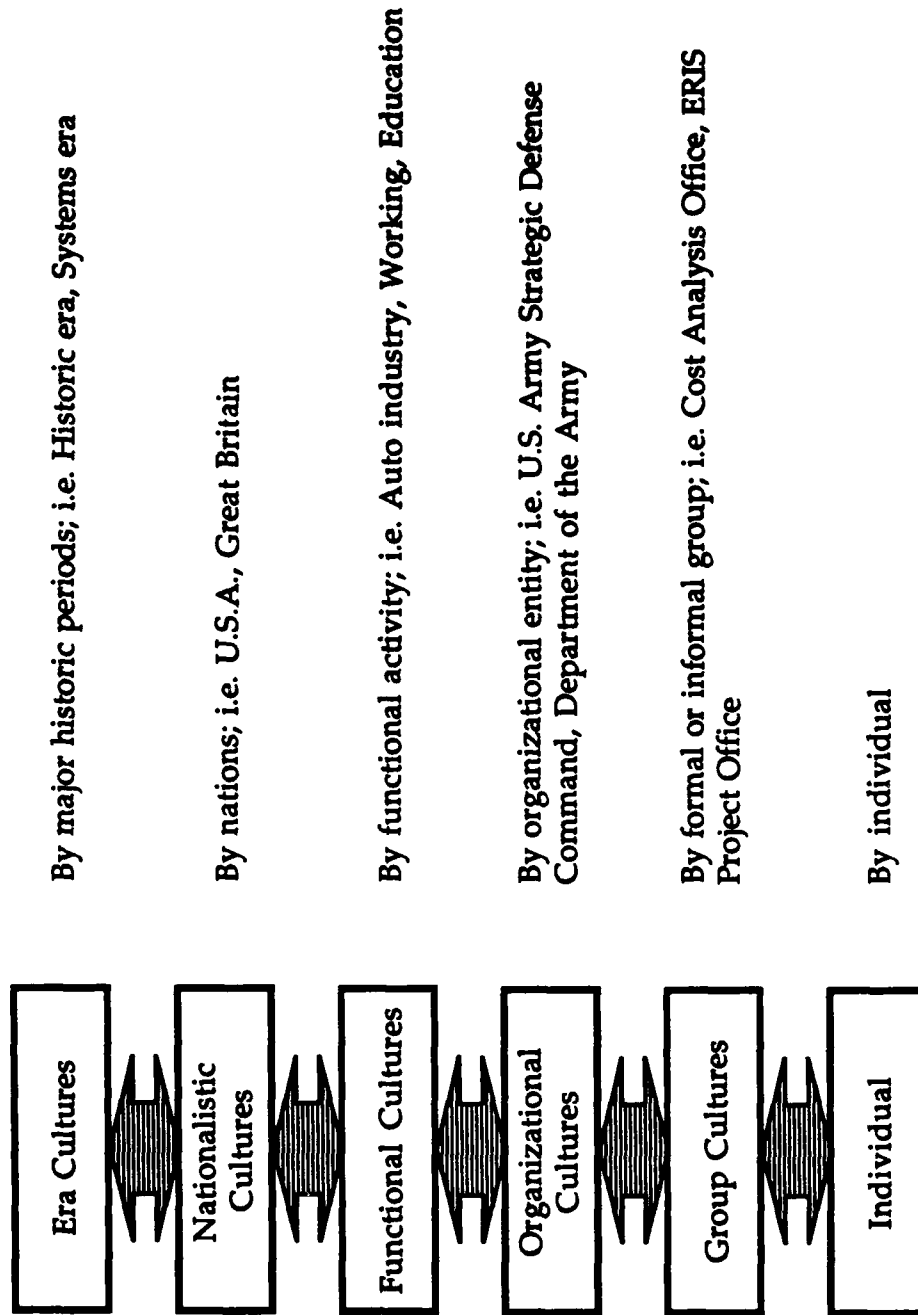
There are of course times in this report where the discussion will specifically illuminate nationalistic cultures in order to draw comparisons between U.S. cultural phenomena and the Japanese culture, for example. There are also sections where the relevance of the discussion is particularly pertinent to organizational cultures. The thrust of the research, however, was aimed at the functional level, and the nationalistic and organizational cultures were viewed generally as boundary limits on the research field of view.

Figure 1-5 displays the culture of interest and its main causal factors. Labeled "ergonculture" from the Greek "ergon" meaning work, it depicts the author's view of a very broad array of difficult-to-define concepts reduced to a workable and appropriate level of definitization and definition. The ergonculture is, by definition, that segment of our total culture that relates to working in human life and, therefore, most specifically to our views on productivity.

Figure 1-5 also depicts the four elements of the ergonculture most likely to influence it: technology, social, economic, and political. Shown in the figure as separate and distinct, the four are very much interrelated and interdependent. They are discussed individually as parts in this report, but in terms of the larger cultural whole.

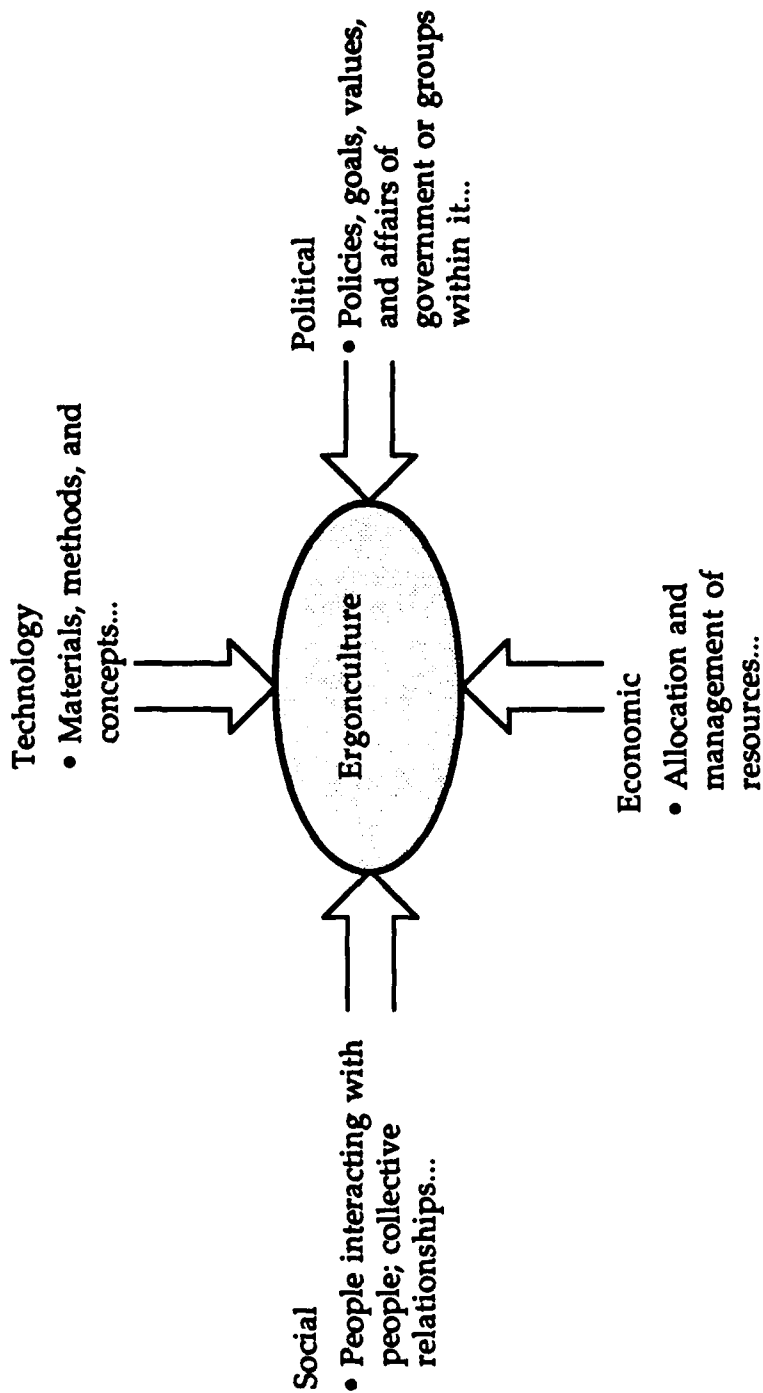
During the course of this research, a lively discussion ensued as to the definition of the term *culture* for it is elusive. Of specific interest was whether culture is the sum of all non-biologic human characteristics or whether inherited characteristics are also somehow inherently involved. The question is strikingly similar to one of the most compelling questions in developmental psychology that focuses precisely on the heredity-environment issue. Also referred to as the *nature-nurture*

Figure 1-4 A Cultural Hierarchy



A particular culture has validity only for the group in which it prevails for it cannot be judged impartially by others of a different culture.

Figure 1-5 Major Elements of Ergonculture



The ergonculture is the composite of all non-biologic characteristics of human behavior including thought, aspirations, values, and beliefs, as they relate to working in human life, and depends on human capacity for transmission to contemporaries and to succeeding generations.

controversy, the issue centers on the roles heredity (biologic factors) and environment (non-biologic factors) play in determining human development outcomes. Lefrancois states that although polemic positions are invalid, most of our theories of psychology emphasize the importance of environment. This thesis, coupled with Wren's assertion that culture relates to non-biologic characteristics, aided the author in arriving at the definition in Figure 1-5.

The cultural framework having been constructed, we turn now to a related construction of the productivity perspective.

Productivity Perspective

Just as energy sources fuel the engines of power that perform physical work, human beings fuel the engines of organizations that transform inputs to outputs. But the human side of the equation is not as productive in the U.S. as many believe it should be, can be, and ought to be. Low productivity is particularly disturbing to the DOD because of increasing competition for scarce resources and increasing cost trends. The cost of new defense, space, and weapon systems has been increasing at an exponential rate since the end of World War II (WW II) (See Figure 1-6). While decreasing productivity is not the only cause of these increasing cost trends, it is a critical causal component and one that can be attacked aggressively by the defense industrial community.

A special report series of articles in the June 6, 1988 *Business Week* indicated that manufacturing productivity for the decade of the 80s thus far demonstrated an average annual growth rate of 3.5 percent. This compares to 1.4 percent during the period 1973 to 1979. But unfortunately, it's a good news—bad news tale. The good news certainly is the increase in productivity over the previous decade. The bad news is that the annual rate shot to 6 percent in 1983 and has been declining for the past five years. Even worse, the experts believe the rate may not be stable and may decline further. As this report was being written it was reported on August 5, 1988, that productivity dropped in the second quarter to a 7-year low by declining 1.7 percent.

The theme of the article is a call for increased output without boosting employment. Why? Because upward surging productivity provides the needed leverage for economic development and growth. As productivity rises, we gain more output for a given input level without cost escalation. Good for the nation, the national economy, our international competitive posture, and for DOD which can get more defense for the same price or the same defense for a lower price.

In the President's FY88 Management Message, President Reagan stated:

The private sector knows attention to productivity is essential to survival. In successful firms, productivity is a way of life, and directly related to the bottom line. It has

to be. The Federal Government, on the other hand, has evolved ways of working that in too many cases ignore or discourage productivity improvement. With federal civilian employment at nearly three million in 1986 and military employment another two million, emphasis on increasing productivity is clearly needed.

As a response to the need, President Reagan announced in 1986, a major new initiative to boost productivity by 20 percent in selected programs between 1986 and 1992. This reflects an average increase each year of approximately 3 percent.

The term productivity, like the term culture, is elusive. For some, it has only an efficiency facet and the two words are synonymous. For others, it is broader gauge and includes a second facet—that of effectiveness. For purposes of this research, the term productivity has four inherent elements expressed by the following four equations:

- Efficiency:

$$E_1 = \frac{\text{Resources Consumed}}{\text{Resources Required}}$$

- Effectiveness:

$$E_2 = \frac{\text{Output}}{\text{Mission}}$$

- Utility:

$$U = \frac{\text{Mission}}{\text{Requirement}}$$

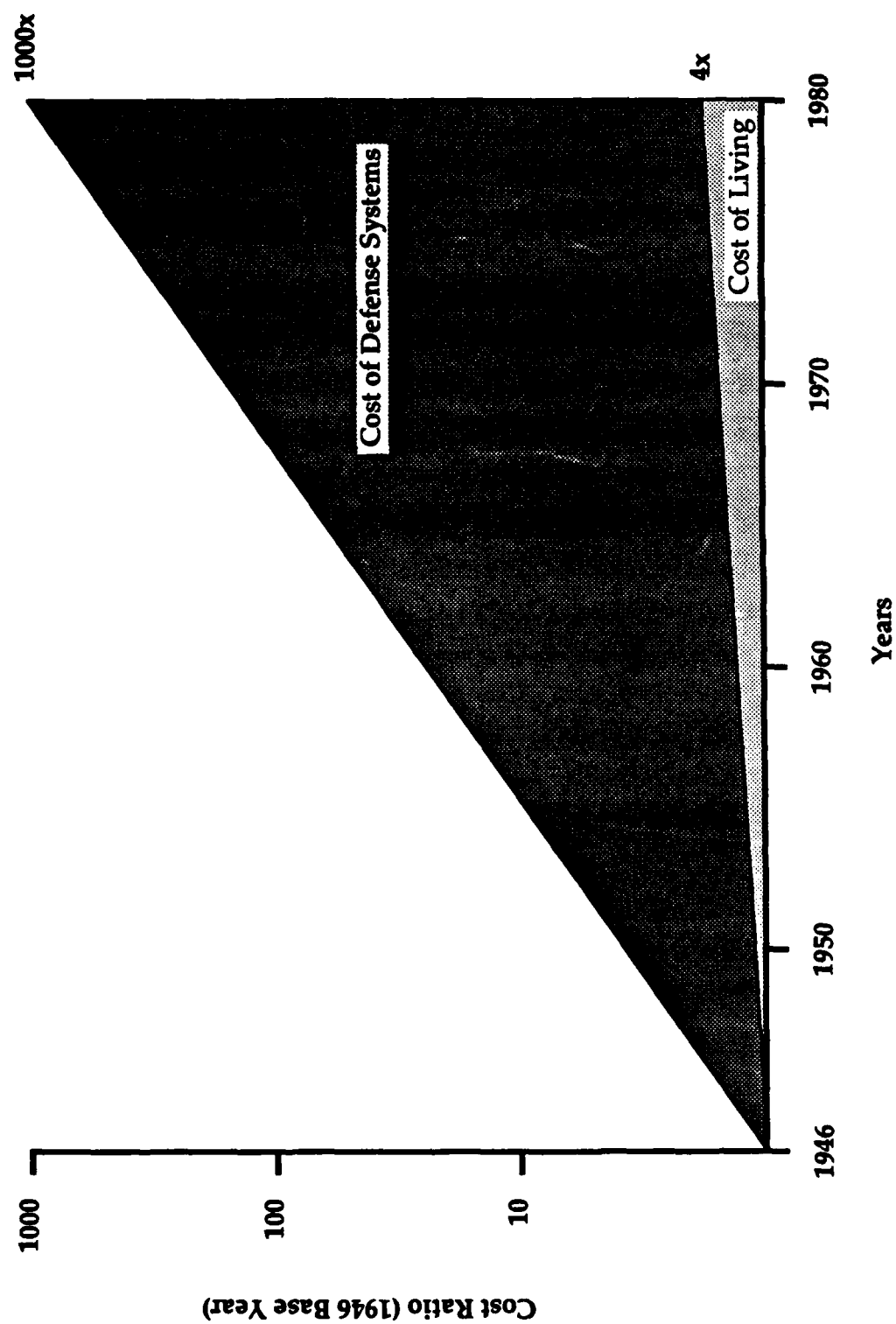
- Quality:

$$Q = \frac{\text{What Is}}{\text{What Ought To Be}}$$

It is recognized that these equations are not true mathematical relationships, but they demonstrate the four facets of productivity as the term is used in this report.

The efficiency facet (E_1) is the ratio of resources consumed to resources required and is a reflection of the effectiveness of resource utilization in the transformation process. The transformation process itself uses some resources, but this requirement is included in the denominator of the ratio. The effectiveness facet (E_2) concerns the relationship between output and mission. From an organizational perspective, the equation is a measure of how well the organization is performing its mission and

Figure 1-6 Cost of Living vs New Weapon System



the choices it makes to accomplish the mission. It should be apparent that in these two facets, the combination of high E_1 and low E_2 is a non-working number.

The third facet relates to the issue of whether the organizational mission as described is a valid requirement. The manufacture of vacuum tubes might illuminate the thrust. A vacuum tube manufacturer in the 1980s could have both high E_1 and E_2 and still not be productive because of low U . The Tucker and Edsel automobiles offer still additional examples.

The quality facet is related to craftsmanship. It is a function of how well the organization conforms to true requirements; i.e. customer requirements. A measurable outcome of the quality facet is customer satisfaction. In the private sector, customer satisfaction or dissatisfaction is frequently reflected in gross sales. In the public sector, customer satisfaction is not as easily and quickly measured.

Having thus defined productivity, one might inquire as to its payoffs. Some have already been alluded to, but the major potential payoffs of robust productivity are:

- Cost
 - Same output with decreased costs.
 - Increased output with same costs.
- Time
 - Same output with decreased time.
 - Increased output with same time.
- Quality
 - Same quality with decreased cost and time.
 - Improved quality with same cost and time.
- Quantity
 - Same quantity with reduced input.
 - Increased quantity with same input.
- Risk
 - Decreased risk with same input.
 - Same risk with decreased input.

While a single product or service probably would not experience all payoffs from a single positive surge in productivity, the manager may in some cases choose from a range of possible payoffs those that will enhance the best outcome.

In a broad sense, productivity is the ratio of outputs to inputs because it is the blend of the four facets discussed above. Productivity is a relative measurement and values are frequently compared to prior values by month, quarter, or some other

timestick. Productivity is also an elusive factor because it is hard to measure and productivity solutions vary extensively in scope and depth from problem to problem. But most of all, productivity is people and attitudes and shared values and congruent goals and reduced throughput time. Both the concept and the payoff of surging productivity are real.

Organization of the Research Report

This report consists of the executive summary at the front and eight chapters including this introductory chapter. The organization of the material parallels the research methodology. It is intended to aid readability and ease of reference.

In addition to this chapter formatting, chapters 2 through 7, dealing with the historical material, are each preceded by a milestone tab that summarizes the pertinent characteristics of the milestone. In each case, the milestone tab sets the point of departure for the material in the chapter that immediately follows.

Chapter 8 presents the conclusions of the author.

Introduction of Writing

Considered in its broadest context, writing includes all forms of graphic communication. Derived from the Anglo-Saxon term *writan* meaning to scratch or score, the word *write* from its beginning meant the act of drawing or carving a surface. This was followed by the later process of tracing or scratching symbols and words.

The evidence of writing separates primitive cultures from civilized ones and marks the division—for historians—between the prehistoric age and the historic era. Some of the earliest written documents of the world as we know it trace to the Sumerian civilization of approximately 3500 to 3000 B.C. The Sumerians were the first civilized inhabitants of ancient Babylonia (now Iraq) and the Sumerian priests were responsible for the business matters of inventory and agricultural records as well as the liturgical matters of faith and morals. As a consequence of their vast tax system, they controlled large amounts of possessions such as livestock, estates, and other forms of wealth. Memory alone was insufficient to the task and the Sumerian priests developed a form of writing—known as cuneiform—to assist in the inventory control process and to facilitate the transmission of records from one priest to another when a priest passed to his eternal reward.

An interesting aside was noted in the *One Voice* newspaper of May 13, 1988, where it was reported that the cuneiform tablet fragment in the collection at Kenrick Seminary in St. Louis is the long-missing half of a cuneiform fragment in the Louvre Museum in Paris. The pieces are estimated to be approximately 4000 years old and are inscribed with a hymn to Nuska, the ancient Sumerian God of Fire. No information is provided as to how the relationship was, at long last, established.

Hieroglyphic writing was in use in Egypt at about the same time as Sumerian cuneiform. Its practice was also limited to priestly authorities and scribes who were of noble rank. Clay was the writing tablet of early Sumeria while stone was the writing tablet of Egypt. It was not until the invention of papyrus rolls and vellum that paper-like material, that did not have to be incised but could be marked by pen, became a working medium. This technology advancement and the later invention of paper by the Chinese also fostered the development of different type styles and penmanship forms because the pen was easier to handle than the stone chisel or reed stylus and facilitated the use of curved as well as angular letters.

The invention of writing, coupled with the realization that measurement of time had significant utility, gave rise to recorded written history. Our earliest annals, listings of events chronologically, were prepared by priests and used for management control. It would appear that the impetus for the development of writing was economic and, from the perspective of this research, driven by a desire for improved productivity.

The introduction of writing was, perhaps, man's most decisive management system technology breakthrough. Certainly it was one that facilitated the socialization of cultures from generation to generation and dramatically improved office management productivity. Coupled with the papyrus roll, placing symbols through one means or another on papyrus and its improved variations would go unchallenged as the principal medium of non-oral business communication until the serious introduction of electronic mail in the second half of this century.

Chapter 2

Historic Era

Historical perspective differs from history in that the object of historical perspective is to sharpen one's vision of the present, not the past.

Barbara S. Lawrence

The historic era, stretching from approximately 3500 B.C. to the renaissance, covers a timespan of just under 5000 years and witnessed a rapid acceleration in cultural achievements in its early years. At the beginning of the period, animals were being domesticated and food plants cultivated, nomadic ways were being abandoned and permanent villages established, and humankind began a marvelous journey to achieve mastery over matter and environment. By the end of the period, the world had witnessed the rise and fall of great civilizations and cities, agricultural productivity had risen to new heights, the first recorded strike had occurred in Egypt, and humankind was emerging into a new world of enlightenment.

Historic Civilizations

Historic civilizations are marked by such characteristics as written records, the use of bronze, permanent cities, and use of the wheel. While some argument still continues as to whether the cradle of civilization was Mesopotamia or Thailand and whether the flow of technology was from Mesopotamia to Thailand or vice versa or occurred simultaneously in both lands, the early civilizations made significant contributions to our cultural heritage. It is to these early contributors that we now turn our attention.

Sumeria

In the Sumerian civilization of approximately 3500 B.C. it was the responsibility of temple priests to manage the worldly goods and business functions of the religious institution. Taxes were levied on the people and paid in varying forms of tangible property. Loans made by the religious order to the people were repaid in like manner. Thus the priests were in the position not only of having to keep track of income and expense items, but also of having to periodically give an account of their stewardship to the chief priest.

The priests responded to this management challenge in a resourceful and inventive manner. They invented a language composed of wedge-shaped letters, called cuneiform, to keep the agricultural and inventory records in a more orderly

fashion than use of notched sticks and memory allowed. In addition to these records, the priests occasionally created a few literary works. The most significant of these works is the *Epic of Gilgamesh* that tells the tale of Gilgamesh the God-King.

The inventiveness of the Sumerians is displayed in their technology which included the use of brick molds, agricultural plows, the potter's wheel, the sailboat, engraving and inlay, and the water clock.

Egypt

The Egyptian culture is frequently remembered primarily for its accomplishments in the construction of the pyramids and irrigation canals, but it was also, in gross terms, a culture of *bureaucratic state administration*. The state administrative structure was large and taxation widespread. Government bookkeeping grew to large proportions because of the extensiveness of the administrative structure, the number of employees on the payroll, and the fact that records of many different activities of the state were maintained. As an example, records were maintained on harvesting operations, wages paid, and worker performance. These latter records, relative to worker performance, were kept as marginal notes, in red, and contained information concerning the worker's absences, productivity (evaluated in qualitative terms of laziness), and finally his death.

Another data base of significance was the recording of the rise and fall of the Nile using a nilometer or stone gauge incised with lines to measure the depth of the water. The Nile was the heartbeat of the agricultural system and its flood level was critical because it determined the bounty of the harvest. These records allowed the Egyptians to be proactive and estimate the probable size of the following season's flood which, in turn, allowed them to estimate harvest size. Indications suggest the Egyptians kept cumulative records on the annual flood, cultivation, and drought cycle. The floods were not, as one might suspect, viewed completely negatively for the swollen river deposited rich silt over the farmland and revitalized its fertility. Dikes protected the villages in the Nile valley when the river left its banks and catch basins collected and held flood water for later use in irrigation.

As exemplary as the irrigation system was of the Egyptian's engineering and construction feats, the great pyramid of Cheops stands in awesome testimony to their prowess. Rising as high as a 42-story building and covering 13 acres, it continues to amaze us more than 40 centuries after its construction. Consider these facts:

- 2.5 million stones were used ranging in weight from 2.5 to 15 tons each.
- The corners of the pyramid are almost perfect right angles.
- The sides face exactly north, east, south, and west.

- The work force may have consisted of as many as 100,000 men for a period of 20 years—in excess of 4 B manhours by today's standards.
- The stones were cut and placed with such precision that a single sheet of paper cannot be inserted between.
- There is evidence that the work force was organized into teams and that few, other than prisoners of war, were coerced into working.
- The builder's tool box contained only primitive wood, stone, and copper tools, and no mechanical aids other than the lever, roller, and inclined plane were used.

Surely the craftsmanship of the pyramid builders is more to be admired than the wealth of the Pharaoh Cheops that financed it. Surely this was a tightly-reasoned, highly organized, and closely coordinated endeavor. Surely this was project management in its recorded infancy.

Babylonia

The Babylonian civilization was approximately chronologically parallel to the Egyptian culture and dates back to 4000 B.C. The farmland, like Egypt, was annually enriched by its rivers' silt and the Babylonians grew rich harvests of wheat, barley, and dates. The Babylonians also demonstrated early recognition of the desirability of record keeping. Whether the Egyptians and Babylonians developed their systems independently or one culture served as tutor to the other is unknown, but many of the management control techniques and account classifications were similar.

About 2100 B.C., Hammurabi (2123-2081 B.C.) became the sixth king of the old Babylonian dynasty and established a central government of power and wealth. Under Hammurabi's reign, Babylon became the commercial and cultural center of Babylonia. Renowned for their military might and sophistication of their legal system, they also demonstrated a splendor in their architecture unexcelled by any other culture of the period.

While Hammurabi's reign was without equal in the history of Babylonia, his greatest legacy to his people was the code he developed for dispensing justice throughout the empire. The Code of Hammurabi contained nearly 300 separate entries and covered many facets of secular activity including trade, business, and marriage. While not the oldest written code of laws, the Code of Hammurabi is the oldest to have survived completely intact.

The use of color coding for improved inventory control was evidenced some years later during the reign of Nebuchadnezzar (605-562 B.C.). As grain from the fields was harvested, it was placed in large earthenware containers and a colored

reed was placed in the seal of each vessel. The grain was stored to offset lean harvests and it was advantageous to differentiate containers by year of harvesting. Each year was assigned a different color and containers could be quickly identified. A simple yet serviceable technique, it must be viewed as both an early productivity improvement and an inventory control technique.

Greece

Tilgher captured the essence of how the Greeks felt about work when he wrote "To the Greeks work was a curse and nothing else." Work was a curse placed on humankind by the Gods and was the price to be paid for the material things of life. Heavy work, in the minds of the Greeks, therefore, was to be accomplished by slaves and those of less than noble rank. Life without work was a happiness known only in the *golden age* when the world was young and all life supporting necessities were to be found in abundance. With the heavy or hard work given to the laborers, the elite would be free to pursue their quest for knowledge and to think about things like philosophy, politics, literature, and art.

The contributions of Socrates (469-399 B.C.) are manifest in many areas of thought and Aristotle (384-322 B.C.), by rejecting mysticism and searching for true knowledge, is given recognition by Wren as "The Father of the Scientific Method" and as having constructed the "... intellectual foundation for the Renaissance."

Socrates stressed the universality of management in describing the expertise required in administration. He reasoned that a good manager in one organization would do equally as well in any other even though the product or service was totally different. Because management skills were transferable, the difference between the management of public and private affairs differed only in magnitude.

Aristotle, one of the most profound and influential of the Greek philosophers, inquired penetratingly into such areas of knowledge as politics, astronomy, metaphysics, ethics, logic, literature, physics, economics, psychology, and biology. It was through his position as tutor to the son of Phillip II of Macedonia—who became known as Alexander the Great—that Aristotle's philosophy made its way to Europe. Alexander formed a great admiration for his mentor and as he established his Greek-speaking empire, the Greek philosophy which was largely based on Aristotle's beliefs, spread with it. It was from this framework that western culture and science grew.

The fifth century B.C. Greek historian Herodotus, labeled three Greek engineering feats on the island of Samos as three of the greatest achievements of his countrymen. The first, a tunnel measuring six feet high and six feet wide travels 3,400 feet through a limestone mountain. Built in approximately 525 B.C., the most amazing engineering feat is that construction started on both sides of the mountain simultaneously and consummated in the middle of the mountain. Because the

tunnel was critical to the defense of Samos, completion was of utmost urgency; hence the use of two construction crews. The other two constructions, a temple and a harbor were destroyed, but the Samos tunnel remains to this day as evidence of Greek engineering prowess.

In addition to these contributions, we must also remember Thales (c. 625 B.C.) and his theory on all matter consisting of elements, Leucippus (c. 450 B.C.) who conceptualized the atom, and Democritus—pupil of Leucippus—who built on the basic idea.

India

Kautilya was an Indian statesman and Vizier to King Chandragupta around 300 B.C. Like others that followed in history, he wrote his *Arthashastra* (the oldest book in extant Sanskrit literature) as a comprehensive account of general principles and specific rules concerning the governing of an empire's internal administrative and foreign affairs. While Kautilya predates Machiavelli by over 1,500 years, he was *Orthodox Machiavellian* in his outlook.

Kautilya was concerned with the difficulties of securing men of sufficient trustworthiness to serve the state with integrity. He saw this as a basic problem of administration, and his solution was one of extensive administrative control and performance assessment. As an example, he specified daily analysis of employee results in terms of cost, time, and functions performed. Carelessness and error were to be dealt with harshly through fines and punishment. While no mention is made of productivity directly, it appears that output was of compelling concern.

Rome

If Cicero speaks for Romans, then they copied the belief of the Greeks with regard to their outlook on working. Cicero saw only two occupations fit for a free man and they were farming and big business. Virgil (70-19 B.C.), on the other hand, in his pastoral poem *Georgic I*, provides a sense of insight that suggests that working might somehow contribute to man's happiness on earth; might somehow be beneficially instrumental—rather than a curse—in man's development.

The Romans, and the Greeks as well, tied their theory of work with their theory of wealth. They viewed wealth as not inherently evil, but to be judged on the merits of its use.

The administrative structure of the Roman Empire attained vast proportions and the basic control mechanism of the state was its military prowess and strength. The geographic dispersion of the Roman colonies presented problems initially and the government sought to ease the burden by contracting out such public activities

as collection of customs duties, titles, and fees; mining operations; and provisioning of the field forces of the army. This system ultimately proved unsatisfactory and under Augustus, public functions that had been contracted out reverted to internal state activity by making civil servants of the former contractors. This administrative reform proved highly successful. It is interesting to note that the proper balance between government *in-house* activity and contracted activity is still a matter of specific attention even today.

Evidence is found that confirms that the Roman culture had guaranteed currency, an early corporate form of joint-stock companies operating under state control, strict state regulation of economic life coupled with liberal commercial policy, and a government of separate executive and legislative powers.

The aqueducts that carried the water for the public baths and fountains stand as proud monuments to Roman civilization. It is estimated that the 10 aqueducts in Rome itself carried in excess of 220 million gallons a day to feed them. The aqueducts brought the water to the city where it was then distributed through a system of reservoirs and lead pipes that a superb engineer, Marcus Vitruvius, warned were a serious hazard to the health of the inhabitants.

The Roman Empire was the most advanced culture the world had seen. As its zenith, Roman rule extended to 50 million people and spread from England in the west to Syria in the east and from all of Europe in the north through North Africa in the south. A complex network of 50,000 miles of excellent roads and 250,000 miles of secondary local roads in Britain and the continent provided the empire with rapid communications. The *Eternal City*—Rome—that stood undefeated for 800 years fell to the onslaught of Alaric the Goth in A.D. 410. While not a fatal blow, the fall of Rome shook the world and crippled the robust empire. The last remnants crumbled in A.D. 454.

Middle Ages

Ancient man was predominantly reactive and displayed few, if any, signs of proactive tendencies. His response to the environment demonstrated a pragmatic approach to coping with his problems. The means devised for record-keeping and inventory control are two representative examples. Contributions to technology and business theory were limited and there is scant evidence to suggest major interchange of ideas, techniques, or knowledge among cultures during the Middle Ages. In great measure, management control was equated to coercive power in large-scale organizations with complex administrative hierarchies.

The Middle Ages began with the fall of the Roman Empire and the outlook for civilization for the next eleven or twelve centuries was bleak. Conditions were hostile, traditional exchange routes blocked, and the period marked by constant conflict and struggle with the Hundred Years War (A.D. 1337-1453) epitomizing the

strife. The primary goal of the populace was survival. This acute need for self-preservation gave rise to the feudal system that lasted until approximately A.D. 1500. In return for protection at the landowner, the serf worked the soil and gave a share of his output and a significantly larger portion of his individual freedom and dignity to the feudal lord. This period was, in Wren's description, a period of stagnation, with education all but forgotten and intellectual life was centered on preparation for the eternal hereafter.

The Roman Catholic Church spread as a faith, but not as an organization. Early parishes operated autonomously and defined their own beliefs relative to matters of faith and morals. But in this process, a hierarchy began to grow and bishops became heads of priests and then some bishops became heads of other bishops. At the Council of Nicaea in A.D. 325, the Bishop of Rome was named Pope and the lineage back to Peter the Rock upon whom Christ built his church was re-forged. With this act, the organization and centralization of the church began to grow although not without conflict. Bishops and priests job descriptions were defined, a chain-of-command from the Pope to the laity established, and a hierarchy of decision making developed. While much of the organization and doctrine of the Catholic Church solidified through the centuries, the issue of centralized vs. decentralized control and the role of the laity in church administration is still an occasional issue of spirited debate even today.

Early man in the Middle Ages was handicapped by his cultural environment, by his limited ability to communicate, and by his methods of gathering, storing, and retrieving information. He was tied to his feudal lord and to the land. The glory of Rome was gone and with it slavery, but the tenant farmers were slaves none-the-less to poverty, illiteracy, and a burdensome life of seemingly endless toil.

Technology

In his quest to gain mastery of matter and environment, historic man solved some early pragmatic problems with technological solutions. Some solutions were specifically sought, some were serendipitous, still others were true discoveries.

Wheel

It is difficult to image life or civilization without the wheel, yet for thousands of years, humankind toiled without it. Equally amazing is that all indications point to the fact that the first wheels were used not for transportation, but in the making of pottery. The wheel was probably discovered in Mesopotamia in approximately 3500 B.C. The first wheels were discs of stone or wood and used as potter's wheel to form clay pots. The housewife of historic times built pots by hand that she needed for domestic use just as she handcrafted the clothes worn by the family. But the potter's wheel was used by industrial specialists that manufactured pottery for sale and

earned their living by such sales. The origin of the first use of the wheel for transportation is unknown. We do know, however, that it was solid (spokeless) and held together by cross-struts. Early wheeled vehicles were probably four-wheeled carts—pulled by oxen—that were used to move goods or passengers for short distances. The invention of the spoked wheel was a major technological improvement over the solid wheel. Coupled with the replacement of oxen with horses, the spoked wheel quickly led to the development of highly effective two-wheeled military chariots.

The wheel brought dramatic change to the world because the existence of effectual wheeled carts forced the development of improved road networks, allowed merchants and armies to travel faster over greater distances than before, and significantly improved productivity. True, continuous, rotary motion for repetitive operations—made possible by the wheel—from the first potter's wheel to the steam engine to today's robotic marvels revolutionized man's mastery over matter. The wheel is truly one of humankind's most magnificent technological achievements.

Hard Horse Collar

While not as utilitarian in its applications as the wheel, the invention of the fitted horse collar in approximately A.D. 500 by a camel driver in China permitted horses to be fully exploited as beasts of burden. In harness for thousands of years, their productivity was limited because the soft collar then in use pulled tight on the windpipe and jugular veins, thus significantly reducing their pulling power. The hard collar was fitted to the shoulders, rigid but padded, and did not interfere with breathing and circulation. It is estimated that the introduction of the hard collar improved pulling power by a factor of four to five times.

The hard collar did not find its way to Europe until approximately the ninth century and by the 11th century many European farms used horses for plowing. In the 12th and first half of the 13th century an agricultural revolution occurred in Europe and food yields were raised to a level that was not surpassed for the next 500 years. Productivity improvements included changes in husbandry, improved plow design, improved crop rotation, and the hard horse collar.

Mechanical Clock

The mechanical clock first appeared in Northern Europe toward the end of the thirteenth century. It is believed that the Chinese had developed mechanical clocks some 300 years earlier, but those of Europe were totally different. The key to successful design is the escapement mechanism because it is this device that slows the descending weight and that determines the cycle of the clock. History does not record the inventor of the first successful escapement mechanism, however, Jacopo

de Dondi (1290-1359) and his son Giovanni de Dondi (1318-1389) both Italian physicians are both credited with having built magnificent early mechanical clocks.

It is known that the use of mechanical clocks spread rapidly in Europe during the second half of the fourteenth century. Not only did mechanical clocks contribute greatly to our understanding of mechanical devices, the clock allowed humankind to accurately measure time as a resource to be budgeted, accounted for, and measured in increments smaller than days. It became another factor for the measurement of progress and improvements in productivity.

Other Technological Achievements

Other technological achievements of the period include:

- The invention of paper by the Chinese in A.D. 105 and the transfer of the technology westward 600 years later.
- The early foundation for photography set forth in approximately A.D. 1000 by the Arab thinker Alhazen in his work concerning the optical characteristics of the human eye.
- The invention of the odometer by the Greek scientist and inventor Hero in approximately A.D. 100 as well as the first steam turbine—called an aeolopile—that demonstrated the power of steam and the law of action and reaction, although not explicitly defined until Newton.
- The use of rockets by the Chinese as weapons of war in approximately 200 B.C.
- The contributions to mathematics and geometry by Archimedes (c. 287-212 B.C.).
- Extensive metallurgical contributions involving the seven metals of antiquity (gold, silver, iron, lead, tin, copper, and mercury) by the Greeks.
- The manufacture of glass in approximately 3500 B.C. by the Egyptians.
- The development of simple devices like the lever, the inclined plane, the wedge, the pulley and the toothed wheel.
- The contributions of Imhotep (c. 2650 B.C.), the first engineer recorded in history, in design and construction of the Step Pyramid of Sakkara, the oldest pyramid in Egypt.
- Harnessing the natural forces of wind and flowing water to replace human or animal power in selected applications.

- The invention of the abacus in approximately 450 B.C.

Technology advances are cumulative and progressive and these early contributions became the foundation for many later accomplishments.

Cultural Significance and Contributions

Culture preserves the achievements and the failures of past generations and is the prologue to the future. Ancient humankind was no exception and left in its wake a basic foundation for future generations.

Technology

Technology prior to the Renaissance was fundamental and pragmatic. It reflected humankind's attempt to master matter, to improve the productivity of agrarian operations, and to establish some degree of managerial responsibility. In specific instances it also reflected man's aggressive tendencies as he attempted to conquer and enslave his neighbor.

While most of early man's discoveries and inventions were aimed at solving immediate problems, some were toys with no realization of the inventor of potential practical applications. These inventors were, perhaps, the original *research for the sake of research researchers*. On the other hand, they may have been limited more by the lack of needed supporting and implementing technology than by lack of vision. Perhaps due to inadequate communication or to the lack of cultural integration, the cumulative and progressive advancement of technology was limited and in a nebulous and primitive state. This is not meant to detract from the contributions made by early man, rather to put them into perspective.

Social

The social structure of early man progressed from individualistic to family, tribe, and finally more formal state orientations. The early church had a significant impact on man's views of working. For the Greeks and Romans it was generally considered a heavy yoke and a curse. The Hebrews, on the other hand, viewed working as a penalty for man's sinfulness and the means of exercising the soul. Tilgher suggests that Jesus' teachings, clearly interpreted and understood, "... do away with the antithesis between material happiness and religious worth..." The Protestant Ethic some years later would seek this reconciliation.

During this period, class distinctions were vivid and there were the *haves* and the *have nots* with the latter bound to the soil. The Middle Ages—the Dark Ages as some writers prefer to call them—were unfortunately a time of great trial. A wave of epidemic disease following the fall of the Roman Empire caused a significant

decline in population as did the Bubonic Plague—the Black Death—in the fourteenth century. Civilization was in a state of disarray and the quest for order, knowledge, and happiness was shoved into a state of suspended animation.

Economic

The economy of early man was largely Agrarian-based. Trade and commerce existed in limited degree, rose to new heights with the rise of the Roman Empire and then declined with it. Most products were made or grown by the family for family use and the creating of capital was a little understood concept.

During the latter part of the period, the goods that were produced for sale were made by either of two forms of organization—the guild system or the domestic system. The guilds consisted of both the merchant guilds who were the buyers and sellers and the craft guilds or producers of the goods. The domestic system, also referred to as the *putting out* system operated primarily in the home. Merchants procured raw materials, provided them to individuals or families who produced the product in their home with their own tools, and then sold them back to the merchant at a cost sufficient to recover their value added to the raw materials. This system obviously suffered from lack of economies of scale and typically the inability of the family to invest in anything but the simplest of tools. There was also no vehicle for lessons learned and cumulative advancement of the technology in the domestic system.

Political

The political element of early culture showed some structure in state governments with the Roman Empire being the most notable. There is ample evidence that early man recognized the necessity and the desirability of organizational hierarchies and specialization of labor both in government administration and armies. Management techniques were largely trial and error with little theory expounded or understood. There was limited exchange of ideas at best and scant evidence that early managers gave any attention to analysis of failures to determine root causes and to document lessons learned. On the other hand, early man established fundamental forms of financial and inventory control and evidenced an appreciation for the inherent value of record keeping.

Early man organized politically around city and state governments until the 800 year domination and collective expansion of the Roman Empire. Following the fall of Rome, the feudal system emerged and was the predominant political configuration until approximately A.D. 1500.

Summary

The historic era is the bedrock of the recorded history of humankind. Performance of the period was primitive by today's standards perhaps, yet today's accomplishments will be equally primitive by tomorrow's yardstick. At the time, many accomplishments were leading edge. While there is some evidence that technology transfer among concurrent cultures did take place, it was so infrequent that specific technologies typically took centuries to spread in the receiving culture. Three notable exceptions are the technology transfer of paper making from the Chinese to the west in approximately A.D. 700, the introduction of the water wheel to China in the first century A.D., and the introduction of the crank to Europe about A.D. 800. These exceptions notwithstanding, accomplishments tended to be ad hoc and there is scant evidence of major cumulative and progressive building of theory, technology, or practice upon previously developed ideas.

The contributions of ancient man (about 3500 B.C. to A.D. 500) far outweigh those of Middle Ages man (about A.D. 500 to A.D. 1350). Ancient man was resolute in his desire to improve his surroundings and environment, altered the world by developing new methods and new structures, and sought to achieve national economic and military security. Ancient man laid a foundation for all that followed by the development of a range of basic tools and simple machines, through continual experimentation with existing materials and by the discovery of new ones including alloys, by the initiation of agricultural productivity improvement, and through the establishment of increasingly complex social and government organizational structures.

Middle Ages man stagnated and his contributions were limited. For a brief period, under Charlemagne (c. A.D. 742-814), founder of the Carolingian Dynasty, it appeared that lasting order would be restored. He campaigned for the unity and security of Christendom and the spread of Christianity. Extensive repairs were made to the network of roads and he established a hierarchic form of government for managing his vast empire. Upon his death, however, it became immediately obvious that the dynasty owed its prowess to the personal strength of Charlemagne. The rule of his successor, his son Louis the Pious, was weak and the unity of the empire was lost.

In addition, Middle Ages man's most magnificent contribution to technology—the mechanical clock—also is the exception that proves the rule. The mechanical clock is a major milestone in the journey toward industrialization.

Put into perspective, these early contributions to our cultural heritage and particularly our views of working life reflect early man's reaction to his environment as he found and understood it, and his goals as he defined and sought them. Not yet visibly proactive, early man responded, survived, and yearned for something better.

Renaissance

The term *Renaissance* was coined by history scholars to label the period of European cultural activity that followed the Middle Ages. The beginning and ending dates are not clearly fixed because the changes associated with the Renaissance occurred in different countries at different times and length of duration varied as well. In a broad sense, however, the renaissance milestone is approximately 200 years in length stretching from approximately the middle of the fourteenth century to the middle of the sixteenth century.

The ancient and modern history scholar Crane Brinton refers to the Renaissance as "...directed toward artistic freedom. . ." and, coupled with the Protestant Reformation, "... both together worked for moral freedom. . ." He concludes that these movements became the foundation of nineteenth century democracy and emancipated ordinary folks from the restraining bonds with which the Roman Catholic church shackled the laity during the Middle Ages.

Cultural patterns during the Middle Ages developed around the feudal system and the Roman Catholic church. Communications were primitive and bickering feudal lords kept small wars smoldering almost constantly. Europe was politically fragmented and the church's spiritual and intellectual doctrine frustrated the development of a differing and coherent artistic, technological, and intellectual culture.

The Renaissance, then, was a period of changing ideas, renewed interest in the physical world, and a replacement of abstract intellectualism with a focus on concrete experience. It also signaled a shift from almost total association of humankind with religious, political, or social orders to an enlightened view of humankind as individuals with differences in capabilities, characteristics, and convictions. Renewed energy was devoted to pursuit of a secular culture, class distinctions so vivid in the Middle Ages began to blur, and a vibrant enthusiasm of individual curiosity about the world and humankind's place in it surged forth.

The Renaissance expanded the known world and ended the period of artistic, intellectual, and technical stagnation. Interest in trade revived vigorously as a consequence of the desire for goods from the East prompted by the Crusades. Political order was restored as feudalism yielded to the establishment of territorial states and quelled the hostilities of earlier years. This stimulation of commerce produced new markets that became new cities and that revitalized old cities and gave them a new beginning. Earlier concepts of property and money assumed new and invigorated significance beyond that of ancient times. The bursting enthusiasm and creative spirit of the renaissance gave birth to the concept of the creation of capital through productive use of labor and material resources. It was also during this milestone that business administration was given another technology blast with the invention of the metallic movable type printing press and double-entry bookkeeping; both significant aids to productivity, scholarship, and communication.

The Renaissance is also the separating milestone between ancient and modern history. It was an age of enlightenment that became the impetus for the cultural changes that fueled the fire of the Industrial Revolution. It was the springboard of renewed interest in the scientific spirit and of a robust cultural rebirth that was underscored by the advocacy of reason rather than authoritarianism in the solution of human problems.

Chapter 3

Preindustrialization

. . . it is essential to establish the necessary links between a new idea and the possibilities of material necessities that it implies.

Bertrano Gille

The Preindustrialization Era, nestled snugly between the Renaissance and Industrial Revolution milestones, covers a timespan almost coincident with that of the Renaissance period itself. This is consistent, however, with most analytical treatments of the era, because the Middle Ages *grew* into the Renaissance and—as we shall see—the Renaissance *grew* into the period of industrialization.

The Renaissance was a time of new beginnings and an age of adventure—a *rebirth* or *revival* of the arts and of learning. The spirit of the Renaissance gave new interpretations to the primary purpose of life which, in turn, gave birth to the concept of creation of capital through productive utilization of labor and material resources.

New Beginnings

Brinton states that ". . . there is some sense in equating the Middle Ages with *authority*, and both the Renaissance and Reformation with *liberty*." Wren refers to the transition occasioned by the Renaissance as a *cultural rebirth* and describes ethics changes that reshaped cultural values ". . . toward people, toward work, and toward profits."

Humanism

If there is to be found a concrete beginning of the spirit of the Renaissance, that beginning is with the humanist movement that emerged initially in Italy. Started by secular men of letters such as Petrarch (1304-1374) rather than the scholars of the church, the movement was non-ecclesiastical in nature and believed that genuine goodness was found in the heart rather than in ritual. Humanism stressed the dignity of man and human excellence and his attempts to exert mastery over matter as the noblest purpose of life in contrast to the medieval view of a life of continual penance as the highest calling. Humanism helped break the hold of orthodox theology on men's minds and created a new consciousness of human thought,

helped develop a new spiritual and intellectual body of knowledge, and inspired a revival of interest in classical wisdom and values.

The spread of humanism was facilitated by the continued failure of the Roman Catholic Church to provide stability in spiritual matters, the continuing decline of the feudal system and the rise in significance of nationalist monarchies, the introduction of the printing press that speeded the diffusion of knowledge, and the use of the vernacular rather than latin in written communication. The movement spread rapidly from Italy north to all parts of Europe.

The term *Renaissance Man* was coined in Italy. It resulted from a Renaissance tenet expressed by one of its most articulate advocates—Leon Battista Alberti (1404-1472)—when he crystalized the essence of humanism by stating "... a man can do all things if he will." This ideal captured the anthropocentric nature of humanism and its belief in man's limitless capacity for development in all fields of art, intellect, technology, science, and social achievement.

The Protestant Reformation

The term *protestanism* is a general term applied to that segment of Christianity that split from papal obedience in the sixteenth century. It derives from the name given the signers of the Lutheran Protest submitted to the Imperial Diet at Speyer in 1529.

Martin Luther (1483-1546) was a monk of the Roman Catholic Augustinian Order. He did not believe himself at first to be a reformer, but rather a vehicle for return to the specific teachings of Christ and the early Church. Martin maintained that earlier advocates of change had directly attacked the corruption visible in church affairs, but that his concern was directed toward the Church's wayward doctrine of redemption. He maintained that he was restoring not changing; that it was Rome that had changed true christian doctrine. Luther believed staunchly in the Augustinian creed of predestination and devout attention to the teachings of Christ as reflected in Holy Scripture.

Luther studied in the monastery and increasingly saw his understanding of Christianity to be in conflict with that of the Church. His most important written work was *Small Catechism*, published in 1529. He also completed his own translation of the bible in 1534. He was tried at the Imperial Diet of Worms in 1521 by the clergy and was eventually excommunicated from the Roman Catholic Church.

John Calvin (1509-1564) has been described as a *cultured humanist*. In approximately 1533, Calvin was converted to protestanism and became an outspoken spokesman for the movement. He defined the first indepth and highly theological treatment of the new reform movement in his *Institutes of the Christian*

Religion in 1536. A two volume set of more than 600 pages each, the study encompasses the whole of Christian faith. While Calvin agreed directly with many of Luther's tenets, he sought a more positive position for law in the Christian community and distinguished more cleanly between spiritual teachings and law than Luther did, but he held firm to the supreme sovereignty of God. Because of his deep interest in and his profound views of the source of political power, Calvin has been called by some the *Architect of Democracy*. Calvin predated Barnard's views of the acceptance theory of authority by almost 400 years, because—in Calvin's view—monarchs derived their power from their people.

Lutheranism spread rapidly throughout Europe. Ruling monarchs were weak and by mid-sixteenth century it dominated Northern Europe. The essence of the Protestant Reformation was interpretation, but its impact was rebellious. Luther was far from being a champion of capitalism, but his views and the views of those that followed were interpreted as a rejection of traditional church teachings regarding the primary purpose of life. Rather than wait passively and prayerfully for initial judgement and eternal salvation, it was man's duty to actively pursue his chosen occupation and present his labor as an offering to God for atonement for sin under the new thinking. The intent was clearly not to build wealth beyond that required for basic needs, but the interpretation just as clearly argued that the accumulation of wealth—in and of itself—was not necessarily evil. If evil occurred, it was in its application not in its accumulation.

The Economic Revival

Maddison, in his *Phases of Capitalist Development*, refers to the period 1500-1700 as *Advancing Agrarianism*. He points out that following the fall of the Roman Empire, Europe lapsed into agrarianism and that for a millennium thereafter "... there was little net progress in population and none in per capita income." While there were significant fluctuations caused by the epidemics of the sixth and seventh centuries and the Bubonic Plague of the fourteenth century, the net progress did not begin to turn upward until approximately 1500. Maddison points out that while the rate of progress from 1500 to 1700 was not that great, it clearly was superior to the preceding millennium. Europe's population increased by approximately one third and per capita output by approximately one quarter. Maddison states that productivity increases did not match per capita income increases during the period because it took longer working hours to produce the increased output.

Maddison contends that the agrarian civilization of 1500 to 1700 Europe was "... an advancing one. . ." and that technological developments and some formulation of capital played a role in this advancement. *Advancing Agrarianism* gave way to *Merchant Capitalism* that covered the period of approximately 1700 to 1820. This was a period in Maddison's view where superiority in maritime navigation, shipbuilding, and development of armaments permitted leading European countries to develop international trade and the discovery of America in 1492 had opened up vast new territories for European exploitation.

In 1776, the great economist Adam Smith (1723-1790) published his *Wealth of Nations* and thus established the *classical* school of economic thought. Smith was one of the first to demonstrate specific insight into the division of labor by recognizing three fundamental economic advantages from such practice:

- Development of dexterity and skill through repetitive performance of a single task.
- Savings of time by not having to switch from one activity to another.
- Development of tools and machines seems normally to follow when men concentrate on tasks of restricted scope.

It is interesting to note that these were not hypotheses of a theorist, but conclusions drawn from empirical studies. It should also be noted that even as he wrote of labor division, Smith was concerned with possible adverse consequences of specialized labor.

Smith also expressed a belief that the tariff policies of the period were dysfunctional because they penalized efficiency and artificially regulated economic activity. He argued that the market factors of supply and demand and the natural force of competition were all the regulation needed. This *invisible hand* of the market would be sufficient to assure that resources would be most effectively utilized and that the greatest prosperity for both individuals and nations would be achieved. Smith's concept of economic liberty attracted supporters from the ranks of the newly emerging entrepreneurs anxious to do away with the suffocating and restrictive policies of mercantilism.

The movement from mercantilism to merchant capitalism was in harmony with the general shift from the authority of the Middle Ages to the liberty of the Renaissance and Reformation. The economic revival was articulated by Smith and his French contemporaries—the Physiocrats—and focused on the natural market harmony of a *laissez-faire* policy of non-regulation.

The Political Revival

The humanists approached political problems from a literary point of view. They were not, however, properly equipped intellectually in the basic principles and mechanics of political science and seldom succeeded in facilitating any political reform.

Niccolo Machiavelli (1469-1527) has been labeled *The Greatest Political Thinker of the Renaissance Period*, but while he understood the culture of the humanists, his political views were realistic. His family held public office for generations and Machiavelli himself held public office for 14 years in the city-state of Florence. He

was an *idea-man* and performed administrative work for the major politicians of the government. He was adept at diplomacy and frequently was sent on diplomatic missions outside Florence. He was in a position to analyze power, and did so by systematically observing behind-the-scenes political activity. It was these observations and analyses that found expression in his writing. He was removed from office when the Medici family was restored to power and it was during this period of enforced activity that he wrote his most noted work, *The Prince*, in 1513. The book was dedicated to "The Magnificent Lorenzo di Piero de Medici" in an attempt to regain the favor of the Medici family.

Machiavelli took a dim view of the basic nature of man and makes numerous references to man as *bad*. On the assumption that men would not keep faith with their ruler, he argued that the ruler need not keep faith with the ruled if it was against his own interests. He advocated deceit—as required—by the ruler, the allusion of good qualities as favorable to actually possessing and observing them, and the ability to do evil if constrained in order to maintain control of the populace.

On internal administration, Machiavelli argued that it was important for a prince to assert his authority by rewarding or punishing any extraordinary act of good or evil in a manner that would be well publicized.

Machiavelli equated management control to power and believed that the ends always justified the means. Because of his writings, his name is frequently synonymous with *unscrupulousness* in politics. The tone of his work was in keeping with the actual, but never openly admitted, practice of the times.

The Medicis—particularly Cosimo and Lorenzo—were forceful personalities of great wealth and were dictators but not despots. The Medicis were dedicated to the revival of classical learnings and thus to the Renaissance.

John Locke (1632-1704) was an English philosopher and author and a counselor in political affairs. He assumed high favor in the court of William of Orange, brought to the throne by the Glorious Revolution of 1688. The essence of Locke's attitude may be found in two passages from his *Toleration*. In the first he expresses his religious belief by stating: "If the Gospel and the Apostles may be credited, no man can be a Christian without charity and without that faith which works, not by force, but by love." On liberty he commented: "Absolute liberty, just and true liberty, equal and impartial liberty, is the thing we stand in need of." For Locke, work was the wellspring of all economic values.

Wren credits Locke's essay *Concerning Civil Government* published in 1690 as a "... great contribution to political theory and as an effective instigator of political action." This reference is based upon the belief that Locke's work served directly the political attitudes of William of Orange, had significant influence on the liberals of England and France, and was instrumental in the formulation of the Constitution of the United States.

Act of 1624

The Act of 1624 in Great Britain swept away the royal abuse of monopoly where exclusive rights were frequently awarded as royal favor rather than for technological creativity. The first patent in England dates from 1552, but it was not until 1624 that invention was truly protected. The act protected the inventor's initiative for 21 years and provided abundantly clear legal incentive for invention. This methodology was extended in 1707 to Scotland and was the basis for the passage of a similar law in the United States in 1790.

The Arsenal in Venice

The Arsenal in Venice was founded in 1104. While its functions always included construction and arming of venetian warships, its main military mission was to serve as a munitions and naval stores depot. Initially it covered about 8 acres, but additions in 1303 and 1325 increased its size to about 30 acres in order to increase its productive capacity. This need was prompted by a decision to concentrate Venetian galley building in the government shipyard. In addition, the arsenal was assigned the new function of maintaining a portion of the merchant marine fleet. The arsenal's mission then remained unchanged for the next 150 years.

Beginning in 1470, the Venetians, spurred by the advance of the Turks, began the formation of a formidable naval fleet. The decision to arm 100 light galleys and 20 great galleys required another addition to the arsenal and it doubled its size to approximately 60 acres of ground and water. At its zenith in the mid-1500s the Arsenal of Venice employed 1,000 to 2,000 men and had expenditures of 100,000 to 200,000 ducats annually. This budget equates to approximately \$4,500,000 to \$9,000,000 at today's values.

Lane reports in *Venetian Ships and Shipbuilders of the Renaissance* that the growth of the arsenal resulted in strict regulation of the accounting process. The system provided sufficient visibility for an accountant in 1564 to determine that internal movement of lumber within the arsenal cost 500 ducats annually and that the clearing of wood kept in front of the slips (to permit launching a ship) cost 1,200 ducats annually. It is recorded that analysis of this data ultimately led to revision of the casual methods used in storing lumber. It appears that completed items of inventory such as benches, oars, sails, rigging, masts, rudders, and spars were controlled in a far more orderly and systematic fashion. These finished inventory items were arranged in flow-of-material order in designated warehouses, with the items to be issued last closest to the exist of the slip. The oar maker's shop had an opening in the wall near the exist for issue of oars—one of the last items to be installed in galleys ready for launch. These methods are clearly an indication of an early appreciation for the productivity achievements to be realized through proper planning and materials flow analysis.

The Arsenal of Venice, in the sixteenth century, was perhaps the largest industrial facility of the time. It was efficient and effective; it maintained physical, inventory, and visitor control; it had standards of quality for acceptance and rejection of raw materials and finished items; and it maintained complete and accurate accounting records.

The Arsenal of Venice was a member of both the Middle Ages and the Renaissance. It is at once both an affirmation of and a contradiction to the environments of the Middle Ages period. The arsenal affirms the survival orientation of the Middle Ages, but it contradicts the technological stagnation. The arsenal reflected sustained growth and adjustment and a high degree of technological sophistication for the period. It exemplifies the fact that movements are not, at any given time, frontiers that sweep in a straight line. The line lags at some points and is more advanced at others.

Technology

The period of preindustrialization was technologically fertile and no account would be complete without at least modest mention of the *Prophet of Science* Roger Bacon (c. 1214-1294). Bacon advocated the use of the experimental technique in science and outlined his thoughts in his best known work *Opus Maius*. His basic philosophy argued that all wisdom comes from God and is revealed to man through the Holy Scriptures, the visible activities of nature, and *internal experience*. Among his visionary concepts were:

- Boats propelled by other than rowers.
- Chariots that would move at incredible speed without horses.
- Flying machines.

Bacon also urged that the inaccurate calendar of his time be modified. The calendar adopted by Pope Gregory XIII in 1582 and still in use today is organized along the lines urged by Bacon. Although it is argued that Bacon had little influence on subsequent technological developments, he deserves recognition as an early scientific visionary.

Printing Press

Johann Gutenberg (c. 1398-1468) was a German inventor and is generally credited with the invention of the movable metal type printing press and printer of the first printed bible in 1456. There is evidence, however, that the Dutch practiced printing with movable type before Gutenberg and give credit to a man named Coster as the true inventor of the method in approximately 1440. Gutenberg did, however, materially improve the process and particularly the quality of the metal type.

It appears that the motivation of fifteenth-century printers was the reproduction of hand-written manuscripts quickly and as inexpensively as possible. It was only later that the design of type styles became an art in itself led by Aldus Manutius (1450-1515) the most notable of all Renaissance printers.

The printing press made possible the rapid diffusion of knowledge and materially improved productivity. The first weekly newspaper was introduced in England in 1622 and the first daily in 1702.

Steam Engine

The first record of the understanding of the potential power of steam was demonstrated by Hero with his aeolopile. Other hints at the properties of steam include Jacob Besson in 1569, Agostino Ramelli in 1588, and Leonardo da Vinci's earlier discussions of a steam gun.

It was not until James Watt applied scientific reasoning and disciplined experimentation that we find the first working design of the condensing steam engine. Watt improved the efficiency and effectiveness of the steam engine through design of the external condenser and other improvements. It used one-third the coal of earlier designs of comparable size and had a power output four times greater. He had a working prototype in 1764, but he didn't sell his first engine until 1776. The first unit was sold to John Wilkenson to be used in his iron works. Watt invented a significant product improvement in 1781—patented in 1782—when he developed a means of transforming the power output of the steam engine from a back and forth to a rotary or sun and planet movement. This improvement had obvious implications for new applications, because a rotating drive wheel can be made to drive machinery with belts or chains.

The power of the steam engine made the invention and fabrication of machines worthwhile because Watt's steam engine gave man the power to drive machines he had always lacked.

The significance of the steam engine is summed in Mathew Boulton's reported comment to Watt in 1769: "... it is not worth my while to manufacture your engine for only three countries; it is well worth my while to make it for the whole world."

Guns and Gunpowder

There is still some argument as to the origin of gunpowder. For some time the credit was alternately given to the Chinese, the Arabs, and even to Roger Bacon. Most authorities now give credit to the Chinese, but gunpowders first use is still at issue.

Gunpowder was introduced in Europe in the thirteenth century. It came from an Arabic formula for the ingredients of gunpowder and Roger Bacon—who could read Arabic—translated the Arabic into the first European knowledge of gunpowder. It was shortly later that the elementary firearm was developed and the feudal castles were no longer the impenetrable strongholds they once had been. The artillery piece or early cannon tended to neutralize the advantage of the fortification and were obviously superior to the earlier Ballista, the Catapult, and the Trebuchet. Charles VIII of France—interested in territorial expansion into Italy—launched his Italian campaign in 1494 with what is called by historians *the first modern army* and introduced explosives in warfare.

Gunpowder and early artillery are generally credited with helping speed the demise of the feudal system. The smaller land owners could no longer protect themselves and only the more powerful monarchs could control manufacture and employment of this new weapon.

Modern Inventions

Leonardo da Vinci (1452-1519) has been described as the *ultimate Renaissance man* competent in every branch of study. While some authorities argue that da Vinci did not originate all ideas attributed to him, he was nonetheless a genius of extraordinary vision. Among his many designs were:

- An armored vehicle resembling the military tank.
- Rapid firing guns with semi-automatic fire.
- Articulated chains similar to the bicycle chain.
- A vertical takeoff aircraft with an aerodynamic rotor similar to the modern helicopter.
- An aircraft with retractable landing gear.

He was truly a man of many talents.

Galileo Galilei (1564-1642) was an Italian mathematician, astronomer, and physicist. We are indebted to him for the compelling role he played in the principles of mechanics, the experimental method, the refinement of the telescope, and the development of a pinwheel escapement mechanism for the pendulum clock.

Isaac Newton (1642-1727) English mathematician was not an engineer, but his three laws of motion are an element of the foundation of modern engineering theory. His publication *Principia* first appeared in 1687 and is viewed by some as the "single most important book in the history of science and technology."

Spirit of the Times

The rebirth of humankind brought by the Renaissance at the beginning of the preindustrialization era revitalized man's intellect, man's spirit, and man's zest for life.

Our technological advances continued to demonstrate our desire to survive and remain militarily aggressive. But they also demonstrated our desire to become more productive in maritime activities and the distribution of written communications. The development of the steam engine was a further step in humankind's desire to master matter.

The engineers and scientists of the time also came to recognize the inherent economic and technological value of modular improvement as a parallel path of inquiry to fundamental invention. The Royal Society was founded in Great Britain in 1660 to encourage the scientific investigation of natural phenomena. In its early years, it focused as much energy to the improvement of existing technology as it did to the furtherance of new technology.

The social element of our culture demonstrated a desire to return to the classics and the emergence of the humanist movement. This focus on the worth of man sought reconciliation with Holy Scripture and man's reason for being. The early humanist movement gave rise to the Protestant reform and what began as an internal attempt at realignment ended in the first major splinter from the Catholic Church. The Calvinistic tenet that stressed the virtue of hard work and thrift and the genuine dignity of man is at the foundation of what is now known as the *Protestant Ethic*—an ethic that clearly encouraged the growth of capitalism.

Humankind advanced economically and developed the fundamental understandings of capitalism. A newly emerging group of entrepreneurs eagerly sought the benefits of a new economic order and accepted the risks associated therewith. For the first time, humankind began to understand the productivity improvements possible with specialization of labor and economies of scale.

Politically the era saw the demise of feudalism and the emergence of nationalistic boundaries and national languages. New ideas of individual liberty and freedom were formulated and man sought perhaps more than ever before, to begin sorting out the entanglement between church and state.

The Preindustrialization Era was the fulcrum for modern man although he did not at the time realize the significance and potential of his multi-faceted actions. While many of humankind's activities were still ad hoc and lacked the guidance of a systemic overview, the pieces were falling into place. Humankind inched a step closer in its quest for order, knowledge, and happiness.

Industrial Revolution

The term *Industrial Revolution* is credited to the English historian and economist, Arnold Toynbee (1852-1883). In Toynbee's eye "... the slowly dissolving framework of medieval industrial life ... was suddenly broken in pieces by the mighty blows of the steam engine and the power loom." As described by Toynbee, the Industrial Revolution was a sudden, almost explosive eruption of industrialization that was off like an arrow from a bow and spread rapidly. Other historians, secure in a broader view particularly of the period following the Industrial Revolution, suggest that the movement was less volatile and gained ground more slowly. Phyllis Deane in *The First Industrial Revolution* examines the differences between preindustrialized societies and industrialized ones and concludes that the shift in England from preindustrial to industrial characteristics was most pronounced in 1750 and that the movement then spread from that point.

The Industrial Revolution was spurred by the development of the steam engine by James Watt in 1765 and marked a period of transition in humankind's technology. It underscored the dramatic shift in emphasis from static technology involving instruments of little or no motion to dynamic technology characterized by energy converters. It diminished humankind's dependence on agriculture and opened the door to surging economic growth.

It should be noted in passing that the Industrial Revolution was preceded by two other revolutions that occurred simultaneously in England. The first was a Scientific Revolution spurred by such scientists as Bacon, Copernicus, Kepler, Galileo, Descartes, Newton and others. These rationalists rescued humanity from the disorder of chance by providing an environment of unflinching orderliness. The scientific revolution was founded on the belief that nature's secrets were best unlocked by experimentation and observation. Their early achievements laid the foundation for later inventions and scholarly pursuits were further encouraged by the establishment of scientific societies such as the Royal Society of London and the French Academy of Sciences. This revolution broke with the idea of science for the sake of science and opened the door for science for the sake of technology and advancement.

The second revolution was the Agricultural Revolution. Starting as early as the thirteenth century, feudal land owners became increasingly productive through improved agricultural practices, crop rotation, improved plow design, and the hard horse collar. As a result of this productivity leverage and the enclosure system where small farms were enclosed in larger ones, fewer farmers were required and many were forced to abandon their cultural heritage. They drifted from their English farms to the towns and cities to seek other employment. It was this ready, large, and inexpensive work force that first filled the early labor needs of the new factories and that acted as a stimulus to production.

The Industrial Revolution was the pivotal historic phenomenon in the shift from a land-based to a technology-based environment. From these crude—then advanced—foundations would come the *Factory of the Future* with machine control substituted for human control in manufacturing processes, automated carousels, smart conveyors, robotics, laser and vision systems coupled with computer-based inspection, and manufacturing precision that would stagger the imagination. And some would argue that the factory of the future is here today at such locations as the Texas Instrument 160,000-square-foot Lewisville, Texas facility.

This world-shaking milestone was a catastrophic break with the cultural heritage of the past and it forced significant adjustment in humankind's thinking about economic, social, and political concerns. The noted historian, E. J. Hobsbawm, observed that "... The Industrial Revolution marks the most fundamental transformation of human life in the history of the world recorded in written documents."

The Industrial Revolution spurred a rapidly moving frontier in industrial technology. Knowledge became action and action became increased mastery of matter and environment.

Chapter 4

Industrialization

Men looked to the future now, not to the past, and perhaps for the first time in history had some inkling of the road to be traversed in times to come.

A. R. Hall

The critical mass of the works of millions of weavers—weaving a fabric without overall plan or design—accumulated in mid-eighteenth century Great Britain. It was not planned by human mind and wasn't even anticipated unless by a scant few visionaries. It just happened. Humankind seized the moment and the fierce challenge of the times and perhaps, as Hall suggests, glimpsed the future.

If survival is the cradle of early man, then initiative surely is the crucible of modern man. Early man fought to survive and was preoccupied with warfare—modern man stepped beyond this preoccupation and entered a new apprenticeship in an emerging and rapidly accelerating world of technology.

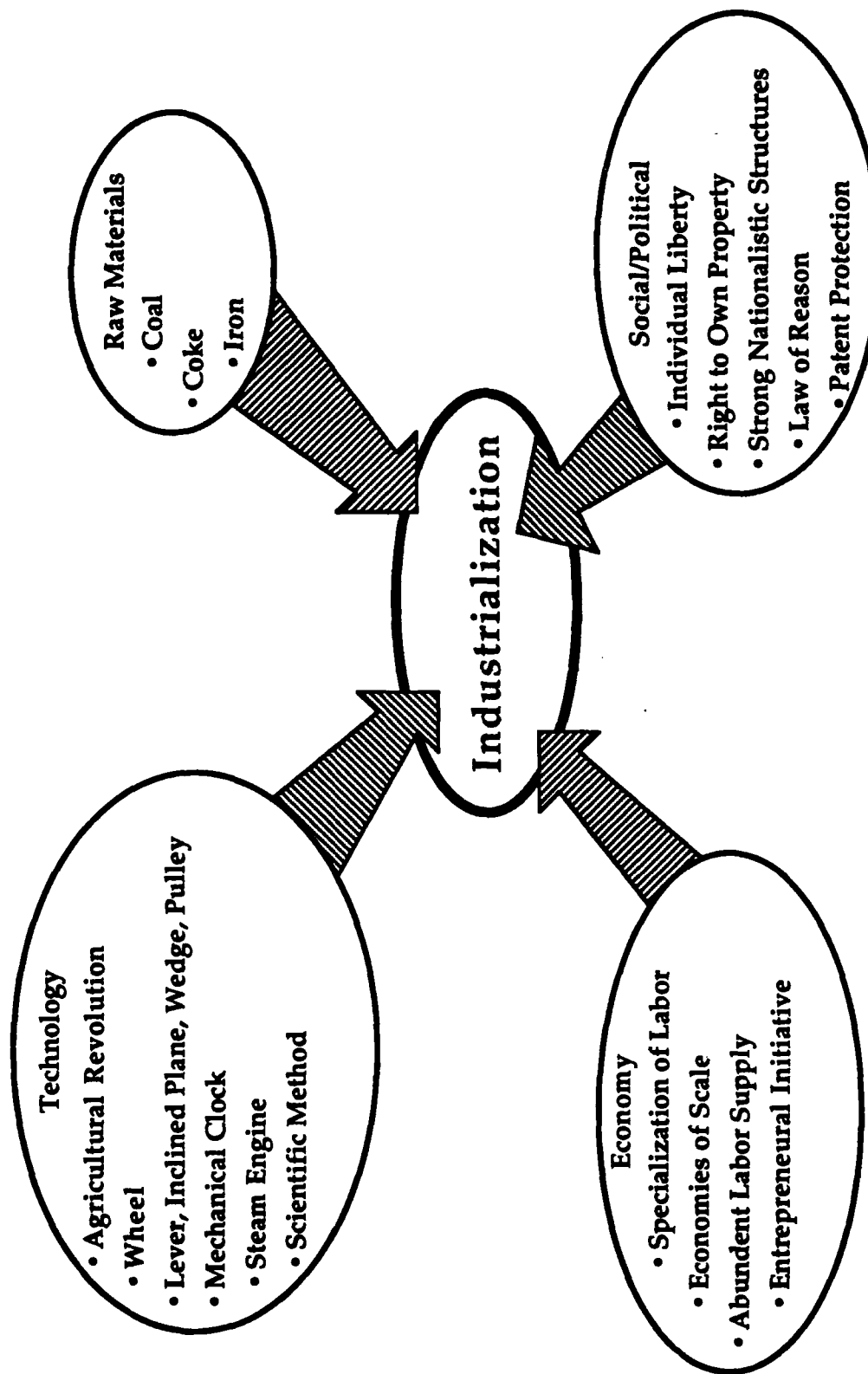
Man knew the *how* long before he questioned the *why*. In early advancements technology developed through trial and error, perseverance, creativity, and a dash of luck. It has only been recently that humankind has sought the *why* systematically through observation, the application of reason, and the experimental method.

The factors that interacted to set the stage for industrialization in Great Britain are complex, numerous, and imprecise. Figure 4-1 is a gross simplification of these factors, but attempts to place major preconditions into meaningful perspective.

Early Factory System

During the Renaissance, two European countries—France and England—ascended to dominance in the development of industrial endeavors. France tended to produce high-quality luxury products for wealthy customers while British industry tended to focus on less expensive goods for a broader market segment. In addition, British industrial manufacturers—on average—were larger than those in France in terms of number of employees, degree of capitalization, and output. When the steam engine emerged as a viable source of reliable power, Great Britain was clearly the leader in mining and heavy manufacture.

Figure 4-1 Gross Simplification of a Complex Process



Modern man esteemed his rich technological heritage, but was not paralyzed in creativity or energy by resting on triumphs past.

The early factories brought together capital, raw materials, the tools and machines of manufacturing, quasi-coherent processes, and workers. Further, the early factory system began the separation of ownership from management of the enterprise.

The factory that emerged with the Industrial Revolution stood in stark contrast with the older domestic system that it replaced. It was a system that accented the prime movers of power and it was a far cry from the old system of cottage work. Major differences in the two systems are depicted at Figure 4-2. The problems presented by the factory system were unique in the history of manufacture. The average worker was far more familiar with an agrarian or cottage-based lifestyle, found factory work monotonous, and disliked the factory-imposed regimentation of rules and regulations.

Control of Performance

The growth of the factory system led to many difficulties, not the least of which was control of employee performance. The complexities of industrialization and organizational size limited each supervisor's ability to personally supervise all activity and there was a lack of trained managers to start with. Close supervision was desirable, however, because the workers in the early factory system were not well trained. Further, there were few, if any, formal training programs so the training that was provided was done on-the-job. No institutions for educating these new workers appeared until well into the nineteenth century.

In this setting, the worker's relationship to his task shifted significantly. Instead of his familiar surroundings working with hand tools, the worker was in unfamiliar factory surroundings working with machine tools. In addition, he was subject to factory discipline and had to mesh his activity into a larger network of activities and do it at the network's pace rather than his own. He was—it seemed—as much a cog in the gears of the machinery he operated as the metal gears themselves.

Quality

Quality was a problem in the factory system in the early years. Control over raw materials and supplies was slack and manufacturing methods lacked standardization. These factors, coupled with a lack of skilled workers, often resulted in products of varying quality. In addition, the early entrepreneurs were *merchant manufacturers* and their first priority was selling their product to an eager market. Development of processes and methods that would yield consistent quality was of secondary priority at best, but competitive necessity ultimately changed this view.

Forbes, in *Man the Maker*, indicates that the steam age brought with a requirement for new precision in the manufacture of machine tool parts. "For it

Figure 4-2 Comparison of Major Factors in Domestic System vs. Factory System

Factor	Domestic System	Factory System
Specialization of Labor	Artisan worked product from start to finish—little synergism	Worker performed specialized, but limited number of tasks—high synergism
Location	Decentralized in homes	Centralized in factory
Skill Required	High/craftsman level	Little skill required
Supervision	Self-supervision	Employer
Regulations	Not restrictive/random	Restrictive/disciplined
Market Target	Production to order	Volume production for mass market
Relative Price of Product	Relatively high	Relatively low
Product Quality	Controlled through pride of artisan/craftsman	Controlled through processes of manufacturing
Production Volume	Relatively low	Relatively high
Power Source	Human	Water and Steam

The factory system left in its wake a new cultural outlook on man's relationship to the tasks of production.

cannot be stressed too often that the mainstay of the evolution of the steam engine and of the Machine Age in general lay in the precision of the machine tools themselves" Forbes wrote. He also indicates that the inventors of the Industrial Revolution "... had an uncanny knack of inventing proper tools that made possible the building of their engines." Holding tolerances was a primary problem, but from solving these problems grew a type of skilled labor that was vitally different from the craftsman of the guilds. The screw-cutting lathe, invented by Henry Maudslay in 1707, was a significant advancement in precision machining of tools and parts and is representative of the ingenuity and capacity of the inventors of the times. Man's ability to make tools to make other tools was ascending technologically at a rapid pace.

Managerial Response

The managerial response to the problems of the factory system were varied, but generally fell into one of two categories. The first—laissez-faire—was devoted to the tenets of the free market and held that the entrepreneur had no obligation to the worker outside of the factory. The worker was a resource to be used as a factor of production. The second—paternal—was a broader gauge view and held that the entrepreneur had an obligation to the worker beyond the factory confines and also to the larger community. This view may have been the first seeds of corporate social responsibility.

Incensetising workers was a problem. For some, the incentive of a steady job with regular wages—independent of the capriciousness of nature—was sufficient. Negative sanctions were also in vogue as some employers levied fines for lack of punctuality as an example, and in some cases locked the gates at starting time.

Some historians report that piece rates in lieu of daily wages were used in some instances to motivate productivity. The rates were set as low as possible by the owners, but it appears that piece rate employees tended to be more productive than employees receiving a fixed daily wage that was not linked to their productivity.

Soho Foundry

Standing as an exception to most factories of the day and as a model that others should have emulated was the Soho Foundry of Matthew Boulton and James Watt. Founded to manufacture Watt's steam engine, the Soho Foundry established systematic work flows, developed and implemented production and process standards, employed standardized components, had an employee training program, and implemented an employee welfare plan.

Watt's original patent was scheduled to expire in 1782, but he petitioned Parliament for an extension at the urging of Boulton. An extension to 1800 was granted by Parliament in 1775. The company produced just under 500 engines in the

25 years from 1775 to 1800 and 308 of them were used directly as prime mover power for machinery.

Boulton and Watt and their Soho Foundry were years ahead of their time during that period. For example, piece rates were established only for those classes of workers with fairly standard and established process standards and then only after standard times had been established for each operation. If experimentation was required to determine what the standard times should be, it was conducted. Workers paid a piece rate received a standard wage for standard performance, but were incensitized by incentive pay above standard.

The Soho Foundry practiced concepts that would be expounded by the scientific management movement a century later. Boulton and Watt were true pioneers, not only in the volume production of the very prime mover that signaled the start of the Age of Steam, but also in their understanding of and concern for tapping the discretionary output of man above standard output without exploiting him or treading on his dignity.

Textile Industry

The textile industry was the heartbeat of industrialization and the emerging factory system. The cotton manufacturer was twice blessed because in addition to the conversion to machine power in the factory, the output of raw cotton from the United States increased from just under two million pounds annually to 85 million pounds annually from 1790 to 1810. This was due both to the use of slave labor on American plantations and the invention of the cotton gin by Eli Whitney in 1793. The abundant availability of raw cotton, coupled with its uniformity and strength and its lower cost in contrast to linen and silk, gave it almost overnight ascendancy as the fabric of choice for a broad market segment.

The Cultural Cost

The cultural costs of industrialization were exorbitant. Great Britain's textile industry was particularly abusive in its employment of children. They worked long hours for very low wages and under harsh and cruel conditions. Children were attractive employees because they were small enough to be very adept at cleaning machinery. They also were used to watch for broken threads and tie them together. Children frequently worked long hours (12-14 hours per day) sometimes beginning as young as the age of five. Female labor did not fare much better than the children and, in addition, there is evidence that some early entrepreneurs took specific advantage of their female employees.

It should be noted that both children and females were workers in the domestic system, so their employment in the production process was not an invention of

industrialization. Further, their employment was centered primarily in the textile industry. Wren indicates that information regarding child and female labor in the factory system is contradictory, and that no evidence exists to support a conviction that abuses were widespread. Further, he points out that there is no data comparing earlier conditions for child and female employees with conditions in the factories.

The use of children under the age of nine in textile factories was stopped in 1833, but the continued use of older children on a part-time basis remained legal until 1918. The textile industry, on the positive side, did offer employment outside the home for females and an opportunity for financial independence. Derry and Williams indicate a conviction that by 1850 the standard of life including conditions, hours, and wages, for adult employees ". . . were almost certainly better than had been enjoyed by any major group of industrial workers in any previous age."

An Exception

As in most cases, an exception is frequently noted and Richard Alkwright deserves mention in this context. Alkwright was both an inventor and an entrepreneur. He constructed a spinning-machine in 1767 that made possible the first use of cotton as warp and with it the manufacture of all-cotton woven goods. While this and later patents were hotly contested, Alkwright is credited as the man that gave Great Britain *the power of cotton*.

Alkwright built his first cotton spinning mill in 1769 in Nottingham. He built a second in Crompton two years later and others in different locations even later. Alkwright is judged as having been an excellent and fair manager. Evidence indicates he was concerned with such things as plant site selection, a careful organizer of production flows and plans, leading edge personnel management, factory discipline, and specialization of labor. He met with much opposition from other manufacturers that infringed on his patents, workers that resented his labor-saving machinery, and a court ruling that his inventions were not original, but borrowed from James Hargraves *Spinning-Jenny*. In spite of these challenges—or perhaps in some part due to them—history records that Alkwright was successful and achieved knighthood in 1786.

Textiles—The Catalyst in America

Textiles were the heartbeat of industrialization in Great Britain and became the cradle of the movement in the United States. Great Britain tried to prevent the spread of industrialization by jealously guarding the secrets that mechanized the textile industry by prohibiting the sale of manufacturing equipment and the emigration of technologists. Arnold Welles, in *American Heritage* records, however, that a technologist—highly skilled in the methods and machinery of Richard Alkwright through direct experience—by the name of Samuel Slater

assumed the guise of a farmer and emigrated to the United States in 1789. Welles records that Slater, then just 21, teamed with an existing small firm of Almy and Brown (later to be founder of Brown University) and introduced Alkwright technology by designing and building equipment from scratch. The result, according to Welles, in 1790 was America's first state-of-the-art mill. Located in the hamlet of Pawtucket, Rhode Island, the methodology and processes came to be referred to as the *Rhode Island System*. Under this system, the firm spun the yarn only and still put out much work to be done in the home as in the preindustrialization domestic system. The *Waltham System*, introduced by Francis Cabot Lowell in Waltham, MA, did not copy this method and manufactured finished cloth directly in the factory. Slater turned to this method in time, as did others, and by the end of the War of 1812, there were 165 mills in Rhode Island, Connecticut, and Massachusetts. Samuel Slater deserves the title *Father of the American Factory System*.

Interchangeable Parts

Interchangeability of manufactured parts is taken for granted today, but it was not always so. For years handmade parts were not interchangeable and would fit only in the assembly for which made. The precision of tolerances was not sufficiently accurate to achieve wholesale interchangeability. There were, of course, some early exceptions. For example, the Arsenal of Venice required that certain assemblies such as bows, sternposts, and deck fittings be interchangeable. This requirement demonstrates their understanding of the production advantages of standardized parts and even, perhaps, their understanding of how standard parts might serve to help achievement of standard performance of the end product as well. Other suggestions of interchangeability include reference to metal printing type in the printing press, but these are special conditions of interchangeability.

George states that Thomas Jefferson observed the use of interchangeable parts in the manufacture of muskets in France in 1785. What Jefferson described was true wide-scale interchangeability of parts that would permit the use of any part on any musket without hand fitting. This was a significant achievement and is evidence of a high degree of precision in manufacturing and of a good quality control program. The implications for manufacture and repair that we take for granted today are obvious.

The American System

Eli Whitney, inventor of the cotton gin, is credited with being the founder of the American System. In 1798, concerned about the possibility of war with France, he recognized that the U.S. Army needed a steady supply of arms. As a consequence, he proposed to Secretary of the Treasurer, Oliver Wolcott, to produce "... ten or fifteen thousand stands of arms" (musket, bayonet, ramrod, wiper, and screwdriver). Negotiations were conducted and Whitney secured a contract for 10,000 stands of arms at \$13.40 each with a period of performance of 24 months. He proposed to

manufacture these muskets with interchangeable parts which was a new concept in U.S. manufacturing. Whitney tooled-up before hiring the first worker. In this process of tooling-up, he invented the machine that was the key to his concept of precision—the milling machine. This invention alone should have earned Whitney a place of honor in American history.

It is interesting to note that Whitney delivered only 500 muskets in the first 12 months rather than the 4,000 scheduled, but the concept of interchangeable parts quickly spread to other industries. Clockmakers in Connecticut began making brass clocks with interchangeable parts, Elias Howe and Isaac Singer applied the technique to the manufacture of sewing machines, and Cyrus McCormick did the same in the manufacture of farm equipment. Whitney added the fuel of motivation to the fire of imagination and implemented his concept of interchangeability—a concept that he mistakenly believed was not known in Europe—that became a landmark in the successful growth of volume production methods and processes in the United States.

The Great Exhibition

The Great Exhibition of the Industry of All Nations was held in London in 1851. English engineering—presented in the cradle of industrialization—took center stage. Attended by six million visitors from every corner of the nation, the exhibition was judged a huge success and it appeared that the British rather enjoyed seeing themselves on parade.

The sleepers of the show, however, were McCormick's reaper, Singer's sewing machine, the revolvers built by Colt, and the rifles built by Robbins and Lawrence. One observer of the American exhibits commented: "The laboring classes are comparatively few in number, but this is counterbalanced by, and indeed may be regarded as one of the chief causes of, the eagerness with which they call in the aid of machinery wherever it can be introduced, it is universally and willingly resorted to." The interchangeability of parts—so evident in the American displays—came to be known as the *American System*. Its application spread throughout U.S. industry and to Great Britain rapidly.

The Railroads

While the textile industry was growing and flourishing in the United States, it never reached the proportions of American railroads, which Chandler refers to as American's *first big business*.

Technology

The bulk and weight of the early steam engines plus their large fuel consumption dictated that they be considered for stationary applications only. Watt's design, however, was followed by the introduction of the high-pressure

steam engine pioneered by Trevithick of Great Britain and the American, Oliver Evans. The application of high-pressure steam increased the output per unit of engine weight. As steam engines became lighter, their application for transportation became increasingly attractive. Trevithick demonstrated a working model locomotive in 1804 by pulling 5 cars loaded with 70 men and 10 tons of freight almost 10 miles at a speed of 5 miles per hour. It is George Stephenson, however, who is considered the *Father of the Locomotive* with his 1814 locomotive in Killingworth, England with its single-flue boiler driving a set of two wheels geared together. His famous *Rocket* in October, 1829, moved at a speed of 29 miles per hour and established practicality of traction between smooth wheel and steel rail.

Early Railroads

The Baltimore & Ohio Railroad was the first U.S. railroad designed to carry both freight and passengers. The train made its first trip in 1830 and was pulled by horses. The early railroads were built primarily to provide local service and were not intended to compete with the movement of freight on the canals. It was not until 1835 that the full potential of the railroad was understood when the Boston and Lowell Railroad successfully and competitively diverted business from the Middlesex Canal. The railroad network in the U.S. began in earnest in 1846 and the Union Pacific-Central Pacific became our first transcontinental railroad with the driving of the Golden Spike—connecting east and west—near Ogden, Utah in 1869.

Competition was fierce in competing lines and gave rise to sharp rate wars and to distinctions in service. Depressed trade, bad management, carelessness in such activities as financing and marketing, and lack of proper maintenance caused many lines to fail. From 1876 to 1901, 638 railroads were placed under receivership representing over \$6B in stocks and shares. In the late 1890s, a strategy of teaming took place and combinations of systems resulted that controlled as many as 20,000 miles of track. While the advertised basis for the movement was economies of scale, the main reason was to restrict competition and, hopefully, gain larger profits. Many of the combinations violated the Sherman Antitrust Act of 1890 and the Federal Government successfully enforced it. At the same time, however, there was growing sentiment that competition among railroads was not desirable. The Esch-Cummings Act of 1920 provided for railroad combinations approved by the Interstate Commerce Commission.

Early Management

Daniel C. McCallum, a Scot who migrated to the U.S. and became General Superintendent of the Erie Railroad in 1854, developed a macro-system of management based on micro-control mechanisms. The system he developed and applied at the Erie included such elements as detailed job descriptions, performance reporting, a hierarchy of authority, and personal responsibility and accountability by

employees throughout the company. He also drew up and published an organization chart for the company. McCallum integrated the newly invented and expanding telegraph system into his communication network for both safety and administration. It is interesting to note that McCallum required each employee to wear a uniform and that the uniform display the employee's grade or rank. Was this a forerunner of Japanese management style in America?

Henry Varnum Poor was editor of the *American Railroad Journal*. He was genuinely impressed by McCallum's management improvements implemented with the Erie and expanded on them. Influenced by McCallum's internal operating procedures, Poor attempted to develop broader-gauge principles coupled with a systemization of management. In so doing, Poor expanded McCallum's work and described a need for detailed financial data to enable analysis of present service and also to provide the baseline for change aimed at improving service.

Poor was—as editor of the *Journal*—the spokesman for the railroad industry. He was a champion for the laissez-faire market spirit and for competition, and argued against near-term gains that were not compatible with industry-wide goals. Poor made a significant contribution to the early body of knowledge on management thought.

The railroads presented imposing challenges to their managers—challenges of a scale and scope not seen before and as the amount of track increased, the problems escalated. Efficient movement of traffic coupled with cost-effective use of locomotives and rolling stock was a significant resource allocation problem, avoidance of accidents was a staggering safety problem, and the cash transactions of numerous employees spread through the system created an accountant's nightmare. The solutions to these problems resulted in new and unique practices involving distinctions between line and staff organizations, decentralized management, the expansion of existing cost accounting systems, and the evaluation of management performance. McCallum and Poor and others like Albert Fink of the Louisville and Nashville and J. Edgar Thomson of the Pennsylvania developed and wrote about their solutions. Their solutions were ad hoc, but—in retrospect—were among the earliest inputs to the U.S. management practice data base.

The Land of Opportunity

America is—from its earliest beginnings—the land of opportunity. The pilgrims believed it, the many eager immigrants to our shores believed and still believe it, and the American rags to riches dream solidifies it. In this dream, success equates to fame, power, and wealth and allows it to occur in any field of endeavor from art to zymurgy. Nineteenth century America was fertile ground for those with the ambition to succeed and the persistence to make it happen, particularly in business.

Conditions of Opportunity

The conditions of opportunity were in place. The doctrine of secular vocation was firmly established and formed the baseline for ecclesiastical support of worldly success, provided the quest was pursued for the proper purposes. The process of industrialization was in its ascendancy and business opportunities beckoned. Earlier, Cotton Mather, colonial clergyman and prolific writer and mold of secular and ecclesiastical cultures of early eighteenth century America, taught that man must succeed in meaningful secular employment in addition to striving to do the will of Christ.

In 1835, Charles Finney published his *Lectures on Revivals of Religion* as a guide for preachers and urged them to break with the stern Calvinism of Europe. Finney was an active Revivalist—as the movement is called—and taught that no matter how sinful, man would be redeemed through dedication to Christ. Dominated at first by the Methodists and later the Baptists, revivalism was characterized by exuberant lay preachers that spread the message from horseback. The movement spread through the country to immigrants and middle class alike as a message of fellowship and salvation. Revivalists are credited as being the driving force in the establishment of the Salvation Army and the Young Mens Christian Association.

Benjamin Franklin—the legendary Colonial self-made man—was renowned for his wisdom and creativity in spite of his lack of formal education. He despised blind adherence to tradition and his name is synonymous with patriotism and morality. Franklin, in his *Poor Richard's Almanac* and *Autobiography* etched the tenets of business prosperity in the minds of his many readers in mid-to-latter eighteenth century America. And, in an historic Papal Encyclical, *Perum Novarum* or *Of New Things*, published May 15, 1891, Pope Leo XIII, recognized the changes taking place as a result of industrialization. He expressed his growing concern that business excesses were emerging that demanded quick correction, but affirmed the Church's reconciliation of material happiness and spiritual worth by stating: "Whoever has received from the divine bounty a large share of temporal blessing, whether they be external or corporal, or gifts of the mind, has received them for the purpose of using them for the perfecting of his own nature, and, at the same time, that he may employ them, as the steward of God's providence, for the benefit of others."

Of Fame, Power, Wealth and Humble Beginnings

The urge to succeed was particularly robust in the areas touched by the Industrial Revolution. This is attested to by the fact that in the nineteenth century America, 75 percent of the newly created millionaires lived in New England, New York, or Pennsylvania, and 70 percent made their newly generated wealth in manufacturing, banking, trade, or some form of transportation.

John Jacob Aster (1763-1848) was born in Germany—the son of a butcher. His early years were years of hardship, but in 1783 he immigrated to the U.S. He sought

employment in the retail fur business, secured it, and in three years opened his own retail store. He became even more successful, purchased a ship, and established himself in the profitable China market. Even the ship's return voyages turned a handsome profit because it returned with cargos of tea and silk. The War of 1812 slowed him down some, but he managed to do a brisk business even then. Even though he was highly successful in the fur business, the majority of his fortune was earned in investments—primarily real estate. By the time of his death, Aster's net worth amounted to \$20M.

Stuart Flexner, in *Listening to America*, reports that our first American to have a worth of a million dollars was probably Robert "King" Carter, a Virginian plantation owner of the seventeenth century. He further records that John Jacob Astor was probably the first American to be called a *millionaire*. The term entered usage as an American word—derived from the French *millionaire*—in the 1820s.

Cornelius Vanderbilt (1794-1877) was born in Staten Island, NY—the son of an impoverished farmer and boatman. At age 16, he purchased a boat with borrowed money and ferried passengers between New York City and Staten Island. His operation grew and during the War of 1812, he secured a Government contract and delivered supplies to outposts throughout the city. He sold his operation in 1818, served as a steamship captain for Thomas Gibbons for 12 years and, in 1829, started his own company. He operated in and around the Eastern seaboard and was a millionaire by 1896. He next turned his attention to the railroads and was highly successful there as well. At the time of his death, his personal wealth was \$100M.

Andrew Carnegie (1835-1919) was born in Scotland and immigrated to the U.S. with his family in 1848 settling in what is now Pittsburgh. He was employed variously as a cotton factory worker, as an engineer tender, telegraph operator, and as an employee of the Pennsylvania Railroad Company. In 1864, he bought property in Pennsylvania that was laden with oil deposits. Carnegie foresaw the emerging demand for iron and steel and, in 1873, concentrated exclusively in that industry. Carnegie's companies flourished in spite of the depression of 1892, and the Homestead Strike where his hired Pinkerton guards were brutally beaten by the strikers. Carnegie stated in his *The Empire of Business*, published in 1933, that every ounce of energy should be focused on the one business that a man has entered. His counsel was "Put all your eggs in one basket, and then watch the basket. . ." Carnegie preached philanthropy all his life and is well known for having exemplified the quality in his own life.

John D. Rockefeller (1839-1937) was a shrewd and cunning industrialist. His first enterprise was dealing in hay, grain, meats, and other goods, but he turned his attention to oil in the early 1860s. He—with a few associates—formed the Standard Oil Company (Ohio) in 1870 and by 1882, the company had a near monopoly of oil in the U.S. In 1881, Rockefeller placed the company and its affiliates under the control of a trust of nine trustees with himself as chairman. This arrangement became the model for other U.S. monopolies. The Standard Oil Company was ruthless in its competitive strategies and, almost single-handedly, was the catalyst for the Sherman

Antitrust Act of 1890. After 1897, Rockefeller devoted himself almost totally to works and acts of philanthropy. During his lifetime, Rockefeller's benevolent works totaled more than \$500M.

These self-made men—a product of the times—have variously been described as ruthless, cunning, shrewd, and pragmatic. Some were described as menaces to society. Their power was viewed as excessive in terms the larger good of society.

This was the era of the self-made man—the era where man from humble origins could succeed through initiative, hard work, persistence, and frugality. But the day was drawing to a close. Wyllie indicates that in 1870 there were only 26 colleges with commercial curriculum in the U.S. By 1894 the number had grown to more than 500 colleges. Technical schools also grew. In 1860, the U.S. had only six schools of technology, but by 1900 there were 42 such schools.

The old self-made men were apprehensive at first and argued vociferously that the only real education occurred on-the-job. But even Carnegie began to recognize that the scientifically educated youth was well trained and more receptive to new ideas. To express his new beliefs, he endowed the Carnegie Institute of Technology in 1900 in Pittsburgh. Other notable initiatives of the time included Stevens Institute of Technology in 1870, the Wharton School of Finance and Economy at the University of Pennsylvania in 1881, the Amos Tuck School of Administration and Finance at Dartmouth College in 1899, the University of Chicago in 1896, and Cornell University in 1865.

The day of the college-trained youth was emerging and conditions were changing. Charles M. Schwab, himself a college man and a Carnegie protege held firm with the maxims of self-made men, but in 1917 crystallized the trend when he said: "Whatever may have been in the past, there is no doubt that to-day industrial conditions favor the college man."

Unionism

The principles of trade unions are inherent in the economic systems of free world industrial nations. Because of this, collective bargaining is the accepted means for settling disagreements on wages, working conditions, and other elements of employment. The American way of life is typically pro-labor and labor legislation is typically favorable to American workers. But it was not always so.

Unionism, as a process of direct and meaningful action, dates to fourteenth century Europe. Early unions involved only the skilled craftsmen in the guilds and the associations focused on providing member benefits and encouraged high standards of craftsmanship. These associations had little power and were unable to check the decline of the guild system as the European economy moved into the new orde of merchant capitalism. As this unionism movement occurred, these

association known in Great Britain as *friendly societies*—became increasingly centered on achievement of higher wages for their members.

The Industrial Revolution was a source of frustration to some workers for they believed that the new machinery would displace them. This fear, coupled with a steady decline in their standard of living, caused some workers in Great Britain as early as 1753 and on into the first decade of the 1800s to smash machinery (labeled *Luddism* in Great Britain after their leader Nedd Ludd) as a sign of their concerns. A major piece of pro-labor legislation was passed in Great Britain in 1833—the Factory Act—prompted by the generally poor conditions of the early factories.

Unionism in the U.S. had its origins in these European (including Great Britain) roots, but it took a different bent from the beginning. The work of American labor during the early colonial period was almost exclusively Agrarian and itinerant. As a result, there was no general movement to form associations until approximately 1750 when a few trade organizations formed among carpenters, tailors, and ironworkers. The American workers were also politically active and in 1739 shipyard workers in Boston formed the Caucus which was copied in other seacoast towns. These clubs became the Sons of Liberty and they actively opposed British rule. It is recorded that their acts assisted in the precipitation of the American Revolution.

The American configuration of merchant-capitalism, following the Revolution, underscored a new wave of competitive markets and cost consciousness on the part of owners. This cost consciousness led to use of lower-skilled workers, depressed wages, and child and female labor. The labor force responded by organizing. The early associations were formed in the 1790s by Philadelphia cordwinder workers and New York printers. These early beginnings spread and by 1837 association roles had swollen to 100,000 workers representing 70 trades in more than 200 locals. At this time, unionism in America was the most advanced in the world.

Employers had also formed associations, however, in an attempt to defuze labor power. The Commonwealth vs. Hunt case was a landmark case in that it found the cordwinder's association to be a criminal conspiracy and illegal. Although it was reversed in 1832, it was the baseline for the People vs. Melvin case in New York in 1809 that declared any activities that injured employers illegal.

Many of the politically active workmen—known as *Locofocos*—joined the ranks of the emerging political party known as the Democrats. Their voice was sufficiently strong that they won concessions in development of party planks and platform. Their success was short lived, however, as the depression of 1837 destroyed their union structure.

The depression following the Civil War also hurt the unions and by 1877 only 20 percent of the labor force was employed on a full time basis. Said in the negative—80 percent of American labor willing, wanting, and able to work was

unemployed or working less than full time. The Molly Maguires (a secret organization of coal miners) of 1875 stood accused of acts of terrorism in the Pennsylvania coal fields and a railway strike in 1877 accompanied by violence and destruction of property fueled the fires of public resentment against labor associations.

The Knights of Labor were a product of these times. While they had difficulty in agreeing on issues, they succeeded in concentrating on mass membership and in 1886 boasted 700,000 members. This number was, however, an extremely small percentage of the total work force, but the Knights—under the leadership of Terence V. Powderly—had influence far greater than their size suggested. Their strength came to an early end as a result of the Chicago Haymarket Bomb incident in 1886 for which they received—unjustifiably—very bad press.

The most lasting of all associations in America was formed in 1886 by Samuel Gompers. The American Federation of Labor was founded on the basis of craft unionism and in that foundation it sought and found permanence. Gompers in his *Seventy Years of Life and Labour* describes his views on unionism and the indirect means he used to achieve political influence.

Unionism was not a particularly powerful force in American industry before 1900. It was building its baseline and searching for identity. At the turn of the century it would begin to emerge as a powerful force in American industry.

Capitalism

A capitalistic system—in its broadest sense—refers to any economic system where capital is privately owned and freely used by the owner of the capital. As we have already seen, capitalism is deeply rooted in our cultural heritage, but the baseline has evolved six stages defined by Maddison as:

- Pre-agrarian
- Agrarianism
- Ancient Imperialism
- Advancing Agrarianism
- Merchant Capitalism
- Capitalism

Mid-nineteenth century economic conditions mark the transition from the fifth to the current epoch. The distinguishing features between the two are the accelerating

pace of technological growth and the accompanying rate increase in the formation of fixed capital, and the introduction of the joint-stock company—a form that has features of both partnerships and corporations.

In the U.S. the period following the Civil War was particularly fertile for capitalism as the Government adopted a relatively laissez-faire economic and market policy that fostered industrial growth. Conditions later changed that made the Government begin to deviate from this laissez-faire policy to bring balance between industry and the broader community.

Theories

David Ricardo, an early nineteenth century English economist, was not formally educated but worked in his father's office at the London Stock Exchange. At age 42 he was sufficiently wealthy to retire from business. Ricardo was influenced by Smith's *Wealth of Nations* and became a fairly prolific writer on contemporary economic issues. Ricardo recognized the productivity increases occasioned by the emerging industrialization of Great Britain, Europe, and the U.S. He believed, however, that since the amount of land was fixed, the productivity growth in agriculture would be far slower. He reasoned that as population grew, the accompanying increased demand for food would not be satisfactorily met and prices would escalate. As this occurred, it would impact the industrial segment and cause prices there to rise as well. If workers were to survive, wages would have to increase which—in turn—would place a strangle hold on profits. In Ricardo's view, this would ultimately cause industrial expansion to cease and stagnate the economy. The performance of the capitalistic system has greatly exceeded Ricardo's restrictive expectations.

Karl Heinrich Marx was a German economist of the nineteenth century and the foremost working-class theorist of his time. He was strongly influenced by the work of Hegel and was the leading exponent of scientific socialism. Marx, and fellow radical and lifelong associate Friedrich Engels, developed a form of socialism known today as *Marxian Socialism*. Marx defined capital as *surplus value* and argued that it belonged to the workers—not the owners—for workers create all existing wealth. Marx postulated that the struggle between owner and worker could only be resolved in a classless society with public rather than private ownership of capital. He believed that the momentum of productive performance would slacken because technical progress could not be successfully sustained. Marx saw the eventual deterioration of capitalism in favor of Marxist Socialism. Marx and Engels' *Communist Manifesto* was first published in February, 1848 and brought its authors worldwide attention.

Joseph Alois Schumpeter, another German economist, but more of the twentieth century, took an opposite view from Marx and saw the entrepreneur as the prime mover of the enterprise. For Schumpeter, capital is a part of the process and is the

means for introducing new products, developing new markets, and creating new processes and sources of supply. In his view, the entrepreneur creates true *profit* which is the value added as opposed to *interest* which is the financial return on ownership. Schumpeter believed that true entrepreneurship was a scarce factor of production, and saw only a few people with those qualities. He believed that people with these qualities arose periodically so that innovation was a discontinuous process and that the economy progressed in cycles.

Many of these early theorists missed totally the role of research and development and the application of the scientific method in the advancement of technology. Early theorists also seemed to ignore or neglect the significance of education in economic development and growth and its potential for improved productivity. Finally, they also drastically underestimated the creativity of the human mind in the quest for mastery over matter and environment.

Newer Theories

More current theorists such as W. E. G. Salter and A. Maddison make a distinction between what they describe as *best practice* productivity and average productivity. They also distinguish between the contributions to economic performance and growth caused by or attributable to economies of scale as distinct from technical progress. This distinction clearly provides separation between *business as usual* processes and practices and the performance that results therefrom and productivity initiatives occasioned by truly innovative and creative technological or cultural advancements.

Technology

The period of industrialization bristled with an array of splendid technological advances that vividly demonstrated man's creative capacity. The achievements of the nineteenth century were pragmatic, varied and compelling, and provided men of vision with more than a passing glimpse of the wonders to come.

Analytical Engine

Charles Babbage, a nineteenth century English mathematical scientist, was the first to write extensively about scientific management. Babbage was skilled in the use of the abacus and in 1812 he invented an improved version of the existing calculator and called it a *difference engine*. His intent with this device was to speed—and thereby improve the productivity of—the computation of mathematical tables. Babbages' difference engine was not considered an advancement of the state-of-the-art by D. S. L. Cardwell in his *Turning Points in Western Technology*, but Babbage's *Analytical Engine* in 1833 was a significant advancement in

technology. The analytical engine could "... handle complex algebraic formulae and carried out a virtually unlimited range of calculations." The data were input to the machine via punched cards—a concept piggy-backed on the punched card technology of the Jacquard Loom that was introduced in Great Britain in 1816. The analytical engine was never completed because Babbage was concerned only with the conceptual definition of the machine and not its commercialization. Had he continued its development, it may well have been our first working digital computer.

There is an interesting aside to Babbage's life. Babbage's work attracted the attention of Augusta Ada, Countess of Lovelace. She was mathematically inclined and understood Babbage's work. She wrote about his work and prepared programs for his analytical engine. The DOD universal software programming language—Ada—commemorates the early contributions of Augusta Ada to programming.

Jacquard Loom

J. M. Jacquard, son of a weaver and a French mechanical engineer and inventor, built on the ideas of earlier silk draw loom designs, but made a state-of-the-art advance in 1801. The idea first came to him in 1790 while repairing looms, but was delayed in application by the disruption of the French Revolution. Jacquard's machine was actually a pattern-weaving modular improvement that attached at the top of the draw loom. The modification consisted of a perforated wooden block covered by a perforated card. The card perforations were specifically designed to expose some perforations in the wooden block while covering others. A series of spring-loaded, horizontal rods were aligned with the holes in the block. When a rod passed through a hole in the card, it entered the block; when it encountered solid card, its spring compressed and the rod did not enter the block. The rods controlled the inclusion or exclusion of warp threads. The cards—connected in a strip—passed across the block in succession with each corresponding to the proper selection of horizontal rods needed for a single weave of the weft. When the flying shuttle traversed the fabric, a new card was positioned over the block for the next pass. The Jacquard Loom was our first application of digital control to a machine tool and is an early illustration of how technology is cumulative and progressive. The loom gained Jacquard the Cross of the Legion of Honor. With Napoleon's encouragement, the Jacquard Loom spread throughout France. It was introduced in England in the 1820s and its use spread rapidly and was adapted for weaving additional materials beyond its original application to silk threads.

Others in the Array

Other technological achievements in the nineteenth century array of splendid technological advances include:

- Entry in 1800 into the second phase of electrical experimentation when an Italian physicist and electrical engineer, Alessandro Volta, fabricates the first electrical battery. The unit of electrical potential difference—the volt—is named in his honor. The first phase of experimentation was general curiosity exhibited by Franklin Van Musschenbrook and culminating in the Leyden Jar.
- The first submarine is invented by Robert Fulton in 1801.
- Francis Cabot Lodge organizes production into a continuous and mechanized flow in one building in 1814.
- Francis Ronalds, British electrical engineer, conducts first experiments of electrical telegraph using static electricity in 1816.
- Andre-Marie Ampere, French physicist, philosopher, and electrical engineer establishes electro-magnetic theory in 1820. The International Congress of Electricians named the practical unit of electric current—the ampere or amp—in his honor.
- Michael Faraday, British physicist, begins experiments in 1821 that culminate in the discovery of electromagnetic induction and the demonstration of the first electrical generator in 1831. This work is the third phase of experimentation. The unit of electrical capacitance—the farad—is named in his honor.
- Georg Simon Ohm, German physicist, discovers relationship between electrical current, potential, and resistance—now known as Ohm's law in 1827. The practical unit of electrical resistance—the ohm—is named after him.
- Samuel Finley Breeze Morse, American inventor and legendary hero of American technology, developed practical telegraph and demonstrated model in 1835 and developed Morse code in 1838. His telegraph was used for the first time in 1844 between Washington, D.C. and Baltimore.
- Charles Goodyear vulcanizes natural rubber in 1839.
- The daguerreotype is introduced in France in 1839 by Louis Jacques Mande Daguerre.
- Roland Hill introduces envelopes in Great Britain in 1840.
- Sir Joseph Whitworth, British manufacturer and engineer, who regularly machines to tolerances of one-millionth of an inch, proposes the use of standard screw threads in 1841.

- The 41 mile long Croton Aqueduct brings fresh water to New York City and provided for public sanitation and industrial needs in 1842.
- Telegraph cable successfully submerged in English Channel between Dover and Calais connecting Great Britain and the continent in 1851.
- First successful transatlantic cable linking the U.S. and Great Britain completed in 1858. Service in this first cable was unsatisfactory within weeks and a permanent link was not achieved until 1866.
- First practical gasoline internal combustion engine patented in France in 1860, by French engineer Etienne Lenoir.
- Typewriter is invented in 1867. Earlier version was developed in Marseilles in 1833—first commercially successful typewriter was designed by C. S. Sholes, an American printer and marketed by Remington in 1873.
- Alexander Graham Bell patents first telephone in 1876.
- Thomas Edison produces first successful incandescent light bulb in 1879.
- Karl Benz of Germany becomes father of modern automobile by constructing a 3-wheel motor-car powered by a one-cylinder internal combustion engine in 1885—maximum speed is approximately 8 miles per hour.
- George Eastman patents first camera and film under name *Kodak* in 1888.
- Henry Ford develops his first working model of automobile in 1896.
- X-Ray discovered by Roentgen in 1895.
- Marie and Pierre Curie discover radium in 1898.
- Guglielmo Marconi, Italian electrical engineer and inventor granted first patent on wireless transmission of electrical signals by British Government in 1896. His first transmission across the English channel occurred in 1898.

The Quickening Tempo

The age of industrialization was a time of transition, growth, and synthesis. It was ushered in by the Industrial Revolution that started the transition from a agrarian-based to a machinery-based economy. The conditions of opportunity were in place—particularly in the U.S.—and Americans seized the moment and initiated an industrial growth that continues to this day. As a result of industrialization, mankind began to synthesize ideas and piggyback on earlier concepts. Mankind's zest for life—rekindled by the Renaissance—kept pace with the times.

Technological advances continued at a brisk pace. Technology transfer occurred from Great Britain to the continent and the U.S. by both covert and overt means and then the pupil began to teach the teacher. Modular enhancements of existing technology was demonstrated and forged its utility on-the-job. Technology synthesis brought new applications to existing technology and then fostered new technological advances as inventors sought greater levels of performance from their inventions on all fronts.

The social element of our culture responded to the new opportunities and continued to strengthen the reconciliation between material wealth and happiness on the one hand and spiritual grace and worth on the other. The ills of the early factory system were slowly recognized and society sought and secured an initial prescription for recovery—and then began applying it slowly but surely. These early measures, however, were more promise than cure. Humankind began the transition from a rural-based to an urban-based life style with difficulty and sought solutions there as well.

The advancements and achievements in the economic element of our culture rivaled our technological advances. Capitalism continued to mature as the newly created capitalists began to recognize that the real purpose of wealth is not wealth itself, but is to create new work, new methods, and new wealth. The heroes of the age and the brand new *self-made men* discovered that fact rapidly. They grew and expanded and changed demand-pull economics to supply-push economics almost in a generation. There was evidence of worker unrest, dissatisfaction, and disillusionment. Upton Sinclair published his book *The Jungle* in 1906 at age 24 to publicize his belief that capitalists were heartless creatures exploiting honest workers. His story hero labored in the Chicago meat processing industry and brought the wrath of the nation and Theodore Roosevelt down upon the industry for its filthy conditions rather than upon the capitalistic structure in general as he had intended. Upton Sinclair is credited with making muckraking a U.S. tradition.

The six-day work week was the norm in the early to mid-1800s. In 1835, Philadelphia implemented the 10-hour working day for civil servants, President Martin Van Buren implemented it for all workers working on Federal projects in 1840, and in the 1840s and 50s, ten states passed 10-hour work day laws. The 60-hour work week soon became standard in the U.S.

Politically, Americans achieved freedom from tyranny, but not freedom from war, either nationalistic or civil. The Louisiana purchase was consummated in 1803 when the U.S. bought 828,000 magnificent square miles at \$.04 an acre from France and doubled the country's size. Uncle Sam became the recognized symbol of the United States of America in the 1830s. The laissez-faire market environment that began the period took tentative steps toward change as Government sought to curb business excesses—Adam Smith's *Invisible Hand* began to have a visible partner. The Gold Rush of 1849 helped open the West although few of the miners got rich. The Civil Service Act of 1883—also known as the Pendleton Act—was passed in

order to bring stability to Government operations by eliminating political favoritism and focusing instead on employee qualifications. The first peacetime federal income tax was instituted in 1894 and declared unconstitutional the next year.

The American Declaration of Independence of 1776 and the French Declaration of the Rights of Man of 1789 changed mankind's attitude toward its environment and proclaimed new states of human liberty. Both declarations also eloquently expressed self-evident truths regarding humankind's inalienable rights and, for the first time, seriously applied them to every man, woman, and child. And—in the words of Derry and Williams—" . . . in the long run the evaluation of a labour-saving device is closely related to the value placed on the laborer."

Scientific Management

The Industrial Revolution led to the creation of the factory system that, in turn, compounded the demands on under-skilled management. The actual and potential productivity of human labor was raised to new heights. The initial gains, however, occasioned a long series of depressing cultural results. Working conditions were inhuman, child labor was uncontrolled, overcrowding in the cities led to slums, and the workers were exploited. In addition, production control was at a primitive state, process control was inadequate, quality control was primarily the responsibility of the buyer under the common law code of *caveat emptor*, materials control was aimed primarily at preventing or minimizing theft, and worker safety was of little concern.

Primary attention during the birth pangs of the Industrial Revolution focused on the quest for solutions to technology problems. This concentration of effort on materials and machines with management processes receiving only scant attention resulted in the former outdistancing the latter, but full realization of the enormous potential of the machine was—and still is—a dynamic integration and interaction of technology, workers, and management.

As the Industrial Revolution spread slowly it also matured. The more flagrant offenses to human dignity and proper working conditions were corrected and law makers began to intervene. It soon became obvious that better working conditions lead to greater productivity and factory owners were ripe for the development of new approaches to factory management. W. S. Jevons in *The Theory of Political Economy* was one of the first writers to discuss the dynamics of the interaction between labor, fatigue, and work loads. He stressed cooperation between management and labor even to include profit sharing and employee stock ownership.

Henry R. Towne (1844-1924), President of Yale and Towne Manufacturing Company and a member of the prestigious American Society of Mechanical Engineers (ASME), presented a landmark paper entitled *The Engineer as an Economist* at a meeting of the ASME in May, 1886, in Chicago, IL. In his paper, Towne stressed that combination of good engineering and good business administration was "... essential to the management of industrial works ..." and that "... shop management is of equal importance with that of engineering. ..." Towne proposed the establishment of a new section in ASME to deal with this concern by the exchange of experiences among managers. It was several years before his recommendation was adopted, but the seeds for development of a body of knowledge had been sown.

Captain Henry Metcalfe (1847-1917), U.S. Army, also presented a singularly relevant and important paper at the same ASME conference. Dealing with a highly effective control system that he had developed and installed at both Frankford Arsenal in Philadelphia, PA and at Watervliet Arsenal in Troy, NY, some years earlier, Metcalfe clearly demonstrated the emergence of applied systemic thinking in the search for order in the factory.

Frederick W. Taylor (1856-1915) attended the 1886 ASME conference and was probably highly influenced by what he heard and discussed while there; with particular reference to the Towne paper. Taylor devoted the remainder of his life to pursuit of a science in management. He published two major works *Shop Management* and *The Principles of Scientific Management* that stand as classics in the search for order in the newly industrialized post-Civil War United States.

Scientific management was truly an ardent response to a brutish problem. As factories grew in size, management grew increasingly insecure in its ability to properly manage labor. As a result, managers eagerly sought solutions to their growing problems with early emphasis centered on labor efficiency. The *Disciples of Efficiency* as Wren labels them, brought forth fresh solutions. They responded with a *Gospel of Efficiency* that precipitated yet another major, vigorous change in our ergonculture.

Chapter 5

The Age of Efficiency

The conservation of our national resources is only preliminary to the larger question of national efficiency.

Theodore Roosevelt

At the turn of the century, there were 18 million-strong metropolises in the world, steamships and railroads were the principal means of moving passengers and cargo, and humankind stood on the brink of understanding that volume consumption required volume production. We also stood on the brink of congruent massive productivity gains. Henry Ford began by producing 100 automobiles a day—in a ten year span, the output had soared to 1,000 a day and the retail price had been slashed almost in half. The moving processing line of the Chicago meat-packers had been converted to a moving assembly line in the Ford Plant. Specialization of labor and economies of scale took on new and substantial meanings as quantum productivity strides were experienced. It was a time of optimism and faith in the future for people of the Western World.

With incredible swiftness, man harnessed forces that obeyed the laws of physics rather than the whims of nature, linked these forces to wheels and gears, and charged into the machine civilization at full throttle. Management searched for new ways to lower costs and be more precise in the production process. Precision in repetitive operations meant shorter manufacturing times, and shorter manufacturing times meant greater production, and greater production meant lower unit costs, and lower unit costs meant increased sales and profits. The days of trial and error, hit or miss management were numbered. Management began to understand problems and processes not so much as isolated elements but more as components of an interrelated whole. The baseline of the manufacturing process had moved from the calendar, to the clock, and now to the stopwatch.

The national challenge was the conservation of material resources and human effort. The challenge of the factory, in the words of Henry Ford was "... the focusing upon a manufacturing project of the principles of power, accuracy, economy, system, continuity, and speed. There was a wide-spread belief that the terms *efficiency* and *good* were synonymous.

The Efficiency Craze

The latter part of the nineteenth century and the first several decades of the twentieth century was an *Age of Efficiency* as managers sought to increase the productivity of their factories and reduce labor intensity. In many areas of management the need for competence still exceeded the supply. There was little system and what did exist—for the most part—was immature, uneven, and inconsistent. Management practice lacked both a body of knowledge and a stabilizing baseline from which managers could draw and upon which they could build.

Definitions

Efficiency meant different things to different people during this era. In one sense it reflected a personal quality or trait that equated to effectiveness. In a second sense it equated to machine efficiency and was the ratio of output divided by input. This was the engineering definition and was quantifiable for machines because matter or energy inputs and outputs were measurable. Finally, it was also used to define the business efficiency of money. It was measured as the ratio of price to cost and the unit of measure was dollars.

Quest for Solutions

The American Society of Mechanical Engineers (ASME) was formed in 1880. Its purpose at that time was to bring focus and collective attention to the issues of factory operation and management. The ASME filled a most significant void in this regard, because other professional societies had largely ignored the problems of the twentieth century factory system and the emerging appeals for efficiency.

The ASME rapidly became a forum for papers on factory problems. In earlier days, the belief was that when the right man was in charge, methods were his to develop, implement, and maintain. As will be seen, this view was no longer viable.

System, Interchangeability, and Efficiency

In research and development efforts or in low volume production activity, the manager generally may focus more on results than methods; more on ends than means; more on output than input. Methods, means, or input are of secondary concern because the lack of repetition or low repetition eliminates or minimizes economies of scale and division of labor as driving elements in the cost equation.

In a similar vein, interchangeability is of less interest in one-of-a-kind or low volume products or goods. The major value of interchangeability in the repetitive process is the economies of scale achieved through repetitive fabrication of identical parts and in the ability to randomly select rather than hand-fit parts in the assembly process. For example, parts interchangeability did not assume the same importance in Noah's construction of the Ark as it did in Whitney's fabrication of 10,000 muskets.

System or method became a major element of efficiency only as production volumes increased. Volume production and moving assembly lines required interactive cooperation among machines, tools, processes, and workers. Interfaces had to be more precisely defined than in non-repetitive operations and process sequence and content became increasing important. The search for efficiency quickly became a search for system.

Systemization

Taylorism—as it was sometimes called—was at the heart of the efficiency craze. Taylor's ideal factory was one of discipline where all tasks had been optimized, all workers had been specially trained to perform their specific tasks, the goals of the workers and of management were congruent, and management assured that all factory gears meshed in unison. Taylor's promise was one of hard work and ample rewards.

Frederick Winslow Taylor

Frederick Winslow Taylor (1856-1915), an American engineer, production man, executive, and consultant, is the recognized *Father of Scientific Management*. Taylor went to work at an early age, temporarily bypassing higher level education, and became familiar with the habits and environment of the worker. Realizing his limitations due to his lack of formal higher level education, he received a degree in mechanical engineering from Stevens Institute of Technology in Hoboken, New Jersey, in 1883, through correspondence study completed in only two and one half years. He also became president of the American Society of Mechanical Engineers in 1906.

Taylor's quest for science in management was based on his conviction ". . . that management ought to be treated as an integrated whole." He wanted to find an answer to what he considered the fundamental question: "What is a fair day's work?" In essence, Taylor sought to determine scientifically what workers ought to be able to output with their tools and materials.

Taylor's approach to management was originally termed *task management*, and his basic motivation was to improve worker performance by showing him how to

perform more efficiently and effectively without injuring his physical being or his health. He utilized time study as a means of analyzing worker activities and then determined the best way to perform a job. He analyzed and developed standard methods for shoveling, manual handling of pig iron, lathe work, and many other manually-intensive tasks. His was a view of micro control at the worker level in its most elemental form. It is interesting to note that Taylor mentions Henry Metcalfe's work at Frankford Arsenal in his text *Shop Management*.

Taylor's incentive plan differed in several substantial aspects with other incentive plans of the time, notably those of Henry Towne and Frederick Halsey. In Taylor's view the emphasis of both plans required worker's productivity gains to be shared with management, which he believed was wrong. Additionally, none of the existing plans determined what *ought* to be done scientifically as Taylor proposed.

Taylor's plan consisted of three main components as follows:

- First, analyze the job scientifically and determine what the *rate* ought to be.
- Second, establish a differential rate that penalized those workers not meeting the standard rate, but that rewarded substantially those workers that met the rate and used proper methods.
- Third, rewards were to go to the workers involved and not be distributed to positions. This would assure that those that contributed received their just reward.

Taylor also believed that the incentives should be paid as close to the period of performance as possible to assure that the worker saw the direct relationship between performance and reward.

Gantt subsequently developed a slightly different approach to incentives that Taylor himself adopted on occasion when conditions warranted.

Taylor emphasized the need for planning and rigorous control of tasks and called for the establishment of a special planning department. He listed seventeen leading functions for the department which included: complete analysis of all orders; balance of all materials, raw materials, stores, and finished parts; analysis of all inquiries for new work; cost of all items manufactured, with complete expense analysis and complete comparative costs on a monthly basis; information bureau (for all drawings, records, and reports); and control of system and plant, including a "tickler" follow-up. His idea of the mission of such a department was summed in his statement: "The shop, and indeed the whole works, should be managed, not by the manager, superintendent, or foreman, but by the planning department."

In 1929, the Taylor Society expressed the following principle of management control as consistent with Taylor's idea of scientific management:

There must be established a systematic procedure, based on the defined standards, for the execution of work; a procedure which directs the research, establishes and maintains the standards, initiates operations and controls work in process; which facilitates each specialized effort and coordinates all specialized efforts, to the end that the common objective may be achieved with a minimum of waste of human and material energies, and with a maximum of human welfare and contentment.

The depth of perception in this principle exemplifies the spirit of Taylor's scientific management.

Taylor also discussed the principle of management by exception coming into use at the time. He argued that the manager should receive summarized information only covering all aspects of business and that even the summaries should be reviewed by an assistant before submission to the manager. All exceptions, both good and bad, to previously established standards or past averages were to be highlighted.

The tap root of Taylor's concept lay in the need for *mental revolution* by both worker and management. The essence of the change was that the worker and management would stop arguing over the division of corporate surplus and work together in harmony to increase the surplus. It is perhaps this precept that most clearly puts Taylor's management thought in its proper perspective.

The advent of scientific management was an evolutionary process. Taylor did not invent scientific management as he himself testified, and he acknowledged similar advanced work of others. But he did synthesize and apply the concepts at a time when widespread industrial expansion was taking place. His work had a profound and lasting influence on modern management thought. Boddewyn synthesized Taylor's work on control with the observation: "His fundamental insight that control rests on measurement was simplicity itself. Taylor's work represents one of our truly significant management milestones.

Harrington Emerson

Harrington Emerson (1853-1931) was a disciple of Taylor and one of the emerging group of *efficiency engineers*. His book, *The Twelve Principles of Efficiency*, outlined twelve principles for study and classification. His thrust was based on the premise that by knowing exactly actual status and comparing it to what ought to be,

it would be possible to determine a direct relationship of efficiency. For Emerson, efficiency was necessary for the total organization from top to bottom. He clearly delineated the need for specific objectives; discipline; comparative records with reliable, immediate, and accurate information; and specific standards and schedules.

His book is also of significance due to his suggested introduction of the concept of military staff into the industrial setting. He recognized the inevitability of line and staff conflict, and his proposed solution gave insight into his idea of executive control:

For these clashes of line with line as to authority, of staff with staff as to knowledge and plans, for these clashes of each member of the line with each separate member of the staff, there is only one remedy—namely, the strong, governing and controlling executive, who need not be an expert in either staff or line, but who must have those qualities that fit him to direct, to harmonize, to convert a close parallelogram of forces into an open straight line along which all forces are summed in the same direction. Everywhere this executive ability is needed.

His concept of managerial ability was reminiscent of that of Socrates in expression of the universality of management.

Frank Bunker Gilbreth and Lillian Mollar Gilbreth

Frank Bunker Gilbreth (1868-1924) and Lillian Mollar Gilbreth (1878-1972) formed a rare husband and wife team in the annals of the history of management. Gilbreth admired Taylor, but worked in a field that he made his own, that of motion study. His wife was his constant companion and her work and record are inseparable from his.

Frank Gilbreth's motion studies were a form of micro production control much in the manner of Taylor's time studies. His analysis of micromotion movements of workers was aimed at the elimination of avoidable effort. According to Gilbreth, in his *Applied Motion Study*, "Motion-study, time-study, micromotion-study, fatigue-study, and cost-study are important measures of scientific management by which the efficiency of each function and subfunction is determined, tested, and checked." Scientific management was management based on measurement. Mrs. Gilbreth described it as an art of directing based upon a science of measurement. While she shared her husband's interest in motion study, she emphasized the relationship between psychology and management.

Gilbreth also applied his call for elimination of needless motion to managers and executives in advising that "The personal work of the executive should consist as much as possible of making decisions and as little as possible of making motions." He argues, therefore, that managers should utilize methods of graphic control based on the exception principle with predetermined "zones". Analysis of charts containing data within the zones was to be handled by lower level managers, with only those charts containing points outside the zone being sent to the executive. He also recommended that exceptionally large positive deviation evidencing unusual efficiency be recognized by the executive and that he take a personal interest in such cases.

Henry Lawrence Gantt

Henry Lawrence Gantt (1861-1919), a mechanical engineer, was another of Taylor's disciples. Gantt was orthodox Taylor in his early career, but in his later life he began to develop more of his own thinking. For Gantt, the human element was all important, and he was a forerunner in the developing idea of *industrial democracy*. His contributions included such major elements as task and bonus plans, training, and production control. While in some respects these and other products were greater contributions in the formation of scientific management thinking, he is best remembered for the development of executive control charts and in particular for the type that bears his name. Much of his original work is reprinted in a book edited by Rathe titled *Gantt on Management*.

Gantt was task and method oriented. He believed that task setting required knowledge, not guesswork—the ability to distinguish between fact and opinion. He also believed that methods were more important than results since if the proper methods were devised, the desired results would be obtained. These concepts, coupled with his stress on fair compensation, naturally led to accurate procurement of individual output, which Gantt put in graphic form.

Gantt made his most memorable contribution in the form of the Gantt Chart while working as a consultant at Frankford Arsenal. It was while on this activity that Gantt revolutionized graphic scheduling techniques:

We have all been wrong in scheduling on a basis of quantities; the essential element in the situation is time, and this should be the basis in laying out any program [sic].

The basic ingredient of the Gantt Chart was born with this unique concept.

A Gantt Chart depicts work scheduled and accomplished in relation to each other and in relation to time. On the chart itself, time is depicted by equal divisions of

column spacing (representing equal time increments) and work planned and completed by a simple combination of numerical data, solid lines of varying widths, and mnemonic symbols. Gantt Charts fall into three basic categories of Man and Machine Record Charts, Layout and Load Charts, and Progress Charts, with the latter being the best known.

It was this technology and the relationship of scheduling on the basis of time that is traditionally credited as the foundation for subsequent developments such as production control boards and methods of network planning.

Of interest is the fact that prior to Gantt, but unknown to him, Karol Adamiecki (1866-1933) of Poland had developed a form of graphic aid called the "Harmonogram". It was in use in Poland in 1896 and was described for the first time in 1903, but his work was not translated into English until 1974. Conceptually, the various Harmonograms were utilized as work-flow network diagrams for the analysis of production processing and for recording status of work in process. They were actually more sophisticated than the Gantt Chart in that they depicted event priorities and the sequential aspects of work-flow, a technique of conceptualization not found in the Gantt methodology. Harmonograms, in fact, closely resemble current network planning techniques such as critical path and PERT networks.

In this country as well, recognition to the necessity of establishing the sequence of operations in construction was evidenced in an article in *Engineering Magazine* in September, 1909. In his article, Herbert F. Stimpson discussed the disparity between the emphasis placed on graphic aids in the form of blueprints and bills of material and the lack of systematic planning in the apportionment of time. He likened the situation to attempting to clothe a two-legged man with a pair of trousers with one leg intact (material) and the other leg missing (time). His solution to this dilemma was the use of equivalent graphic aids for estimated time, handled with the same care and precision as those for materials, broken down to each subordinate group, and with the relationship of times between subgroups identified. Stimpson argued that this was the direct cause of men being *blindly switched* from one operation to another, explained why some machines were consistently idle while others were continually overloaded, and why work was often delayed awaiting critically required materials.

Stimpson summed his argument with this perceptive thought:

We wish to know not only the time that will be necessary for the completion of the operation and of the entire work, but also the sequence in which each part and group must be begun in order that they may be combined at the proper times and in the proper sequence, so that the whole work may be finished at the time which is desirable or has been agreed upon.

While Stimpson's article was not accompanied with illustrations, it is clear that he, like Adamiecki, demonstrated insight into concepts of prospective sequential flow and time analysis in construction where network planning techniques, in later years, are used effectively.

Alexander Hamilton Church

Alexander Hamilton Church (1866-1936), a lecturer and author, was concerned with conditions of industrial confusion and disorder. He criticized scientific management on the basis that in its rush to *apply* it neglected the necessity to *construct*, and he believed that the former had been mistaken for the latter. His book, *The Science and Practice of Management*, was written to consolidate the regulative principles of management.

One of Church's major contributions was to write Volume I of the *Cumulative Loose-Leaf Business Encyclopedia* published in 1928. This volume contained an extensive discussion on the subject of control. Of particular interest is Church's discussion on the use of schedule control boards. He described the need for time estimates, sequencing of interrelated activities, and identification of *steps* in the process. His illustration and description strongly suggest that his *steps* were, by modern standards, milestones and his control board, a milestone chart. This is one of the earliest narrative and graphic references made to a technique similar to modern milestone charting techniques.

Church was one of the earliest writers to look at the total managerial process and to recognize the salient factors of management control.

Leon Pratt Alford

Leon Pratt Alford (1877-1942), engineer, editor, and writer, was also concerned with the implications of scientific management. He coauthored an article with Church in 1910 in which they attempted to formulate a basis for an art of management somewhat in counteraction to the implied *science* of management under Taylor. The authors defined broad principles of the systematic use of experience, the economic control of effort, and the promotion of personal effectiveness. Under the economic control of effort they stated: "Most of the discussions about management are, in fact, discussions about various methods and degrees of controlling effort and fixing its regard;" a broad but comprehensive definition of control.

In his text *Laws of Management Applied to Manufacturing*, Alford continued his desire to formulate principles and he enumerated some fifty laws of management.

In his later text *Principles of Industrial Management*, he expanded the meaning of management control to include not only the commonly understood consideration of direct, govern, influence, restrain, but also added the facets of determining objectives, program and plan to be adopted, leadership, and unification.

Perspective

Scientific management was nudged into the public eye in 1910, when the Eastern railroads petitioned the Interstate Commerce Commission (ICC) for increases in their freight rates. Louis D. Brandeis, a Boston attorney and later made a Supreme Court Justice by President Wilson in 1916, was counsel for the shippers. He immediately seized on the inefficiencies of railroad management and argued that if the Taylor system—Brandeis then coined the term *scientific management*—was applied, no rate increase would be required. The publicity from the hearings thrust Taylor into public view. The ICC found against the railroads, but concluded that it was too early to evaluate the potential merits of scientific management. The public, however, and manufacturers responded favorably to the more efficient management principles of Taylor's concept.

Taylor also suggested that his methods would work in Government organizations. His attempts in naval shipyards had been unsuccessful, but the Army was interested in applying the system to its arsenals. Taylor began at Watertown and Rock Island Arsenals as test cases. The work at Watertown went smoothly, but the time study at Rock Island was resisted by the workers and ultimately resulted in the workers going on strike. A Special House Committee was formed to conduct hearings into the matter and Taylor was treated poorly on the witness stand. The committee's final report found that it was too early to determine the effect of Taylor's system on workers. They further found that there was no evidence of worker abuse and no need for anti-Taylor system legislation. In spite of these findings, subsequent appropriation bills, beginning in 1914, contained riders that prohibited application of any part of the Taylor system to operations funded by the bill. The riders were sponsored by pro-labor forces that clearly misunderstood Taylor's system and his motivations.

Taylor's ideas were not a panacea and his system took time to implement—sometimes as long as five years. The public and many manufacturers were receptive to his ideas, but labor forces continued to oppose his system. Although Taylor offered both Samuel Gompers, President of the American Federation of Labor, and John Mitchell of the mine workers, the opportunity to visit plants using scientific management and see the results first hand, both refused.

Taylor's disciples continued to apply scientific management for many years. The Taylor Society—formed in 1911 to maintain and publicize Taylor's work—was the focal point of the movement. Its membership grew as it opened its doors to all

managers—not just those endorsing the Taylor system. In 1936, the Taylor Society merged with the Society of Industrial Engineers to form the Society for the Advancement of Management. This group is now a part of the American Management Associations.

Scientific management tended to be applied at labor intensive and job shop operations. Scientific management was successful in some applications and not in others. The failures, in some cases, were due to the consultants and, in some cases, due to poor management. There is no reported case where failure was attributed to lack of performance by workers. Taylor and his followers believed that the remedy for industrial inefficiency was to be found in a scientifically established management baseline that, applied correctly, would yield results that would be *truly astounding*.

The Human Side

The *systemizers* of scientific management concentrated on developing *first-class* men in their approach to improved efficiency and took a systems view of the workplace. They focused, however, on the economic facet of man's psyche only and ignored or discounted the psychological aspects of human motivation.

The scientific method of observation, experimentation, classification, and interpretation was—and still is—just as appropriate for the analysis of direct human efficiency. The early industrial psychologists sought to apply this methodology to the specific examination of human behavior in the work place.

Hugo Munsterberg

Hugo Munsterberg (1863-1916) is the *Father of Industrial Psychology*. He was Professor of Experimental Psychology and director of the psychological laboratory at Harvard University when, in the early 1890s, he began to author articles on the utility of psychology in an industrial setting and published them in newspapers and magazines. Written in a manner that sparked the interest of industrialists, Munsterberg proposed the application of psychology as a means of providing a broader framework for the continued introduction of science in management. His pioneering book *Psychology and Industrial Efficiency* praised Taylor as the *brilliant originator* of scientific management and called for understanding and application of psychological considerations in industry in order ". . . to secure the best possible effects."

Walter Dill Scott

Walter Dill Scott (1869-1955), taught psychology and advertising at Northwestern University. During WWI, he developed a system for the U.S. Army for classifying

and testing officer candidates for which he was awarded the Distinguished Service Medal. His work in the psychology of advertising coupled with his broadened perspective on personnel are credited as pioneering contributions to personnel management as an activity of industrial organizations.

Whiting Williams

Whiting Williams (1878-1975) was the Vice President and Personnel Director of a firm in Cleveland, OH when he decided to see what industrial conditions were really like first hand. He disguised himself as a worker and secured employment at a steel mill. He continued the study for a period of seven months, working at several different occupations. His findings were revealing because he established a direct link between job status and social status. This link was critical because it demonstrated that the worker could not be viewed as having a separate work life and social life, but rather was a single individual in a far broader and more complex system.

Williams also observed that workers were not motivated by pay scale alone, but other factors such as the nature of the work, as well. His view was that incentive plans were not effective motivators. The real motivator, according to Williams, was how each worker valued his self-worth in relation to the other workers; group togetherness was important.

Williams' views were penetrating, but his work was not influential at the time. This may have resulted from the fact that he was a practitioner rather than an academician.

Despite these early activities, the scientific management movement was center stage and the social aspect of the worker was largely ignored. But accomplishments are frequently made in phases, and this was the phase of machine efficiency.

Big Business

At the turn of the century, big business and the corporate form of organization were synonymous terms in the U.S., particularly in banking, transportation, and heavy manufacturing. This trend began at the conclusion of the Civil War as transportation, manufacturing, and commerce began a sustained growth.

The corporate organizational form was best described by Chief Justice John Marshall in the Dartmouth College case in 1819 when he defined it as ". . . an artificial being, invisible, intangible, and existing only in the contemplation of the law." But, in fact, every successful private sector corporation is a complex interaction of multiple personalities accomplishing detailed tasks associated with

satisfaction of customer requirements while simultaneously developing new markets, new product lines, and new technologies.

The number one priority of any corporation is survival and all employees realize that they will rise or fall in accord with consumer good will. Any corporation that does not adhere—in some fashion—with the ageless tenet that *the customer is always right* will not long survive in hard times.

Corporations reflect their corporate culture which is a synthesis of their founders' personalities and the circumstances of their founding. When the corporation survives over an extended period, the culture may be tweaked to keep it current, but the basic traditions, precepts, and habits—if worthy—tend to remain intact. Corporate performance reflects this corporate culture and is the accumulation of minute individual contributions, operating systems, and support structures that create steadily increasing value added to both product and service at minimum operating costs. Profit is then made from small margins on many transactions.

Mark Twain referred to the period between 1870 and 1910 as *The Gilded Age* and truly it was. It was the era of the business titans that became industrial capitalists and built immense organizations of great wealth and resources. The trend was toward less competition than before and no restraints on monopolistic tendencies existed. These captains of industry sensed the opportunities and forged forward. They mobilized technology, labor, and capital into industrial dynasties and *Big Business* in the United States was born in the process. *Big Business* was associated with success and society admired both the titan and his success. As Andrew Carnegie said, the quest became *A Gospel of Wealth*.

Productivity Gains

The giant corporation, the creation of the robust industrial growth of the latter part of the nineteenth century, achieved new levels of productivity. One set of statistics, quoted by Wren, indicates that manufacturing output rose from an index of 21.2 in 1890 to 52.0 in 1929 where the base year—1958—has an index of 100. Wren also references another study that analyzed the decline in the number of man hours input required per unit of output and found a 43 percent increase in efficiency from 1919 to 1929.

While much of this gain may be due to the processes of volume production introduced and developed in the early twentieth century, much credit must also be given to improved management techniques—in large measure driven by the principles of scientific management—aimed at reducing input costs. In addition, it is during this same period that the U.S. witnessed the introduction of centrally generated electrical power. The first electrical power station in the U.S. was Edison's generating station on Pearl Street in New York City in 1882. Another milestone was

achieved in 1893 when George Westinghouse opened the first hydro-electrical generating station at Niagara Falls after 16 years of planning. Central power station generation of electricity at high voltages, coupled with efficient means of distribution to large areas, was the genesis of the practical application of electricity to the needs of industry. The conversion to electrical power was rapid and by 1920, approximately 35 percent of U.S. industrial power was electricity-based power.

Smaller vs. Bigger

In testimony before the 62nd Congress, 2nd Session, 1911-1912, Louis Brandeis (of Eastern rate hearings fame) argued critically that business success or failure depended normally on one man. He reasoned that as the business grew larger, the man *at the head* grew less and less familiar with the details as he spread himself thinner and thinner. In addition to his diminished knowledge of the details, Brandeis argued, the top official also had less opportunity to exercise control over business activity. Brandeis gave full credit to instruments of improved productivity such as ". . . new methods of communication, . . . the stenographer, the telephone, and system, . . ." but believed that one man could only do so much.

Theodore Roosevelt, on the other hand, in his book *The Foes of Our Own Household* said "Big business has come to stay." And further that if big business could be ended ". . . it would mean the most widespread disaster to the community." Roosevelt, however, wanted to take a new approach in the preservation of existing institutions by ". . . wise governmental control. . ." that would hold both the corporation and the labor unions ". . . accountable and responsible. . ." for their ". . . deeds and misdeeds. . ." Under Roosevelt's approach, each element would be encouraged so long as it performed properly. He attributed the problems of big business—as he saw them—to the earlier practice of ". . . unlimited cutthroat competition among a multitude of small, weak concerns. . ." that transitioned into more concentrated and larger businesses operating without control. He also recognized, however, that in spite of their flaws, the business tycoons were propelling this nation into industrial world leadership.

Early Success Stories

Henry Ford developed his first working automobile in 1896 and he founded the Ford Motor Company in 1903. He introduced the robust Model T in 1908 and made it affordable. He ignored accounting logic and regularly lowered the price of the vehicle—forcing production costs to be lowered to make it profitable. Ford was quoted as saying: "Every time I reduce the charge for our car by one dollar, I get a thousand new buyers." The moving assembly line arose from this process and was fully operational in 1913. It is reported that the original assembly process consisted of two men towing the chassis through the plant by rope as part by part was added. Ford summed up the concept of the moving assembly line and gave new meaning

to division of labor when he wrote "The man that puts in the bolt does not put on the nut; the man who puts on the nut does not tighten it." From 1908 through 1927, Ford produced 15 million Model T automobiles. This record stood until Volkswagen *Beetle* number 15,007,034 was produced in 1972.

U.S. Steel was the nation's first billion dollar corporation. Founded in 1901 by J. P. Morgan, the event—inaugurated by a festive banquet at a table shaped like the cross-section of a huge steel rail—marked two memorable milestones. First, it was the beginning of the entry of the financier into the trenches of industry and, second, it marked the moment when big business became at least as big as government and dealt with government as an equal. Morgan built U.S. Steel by buying out Andrew Carnegie and combining Carnegie's steel empire with that of his chief rival. At its formation, U.S. Steel controlled 65 percent of the steel production in the U.S. The days of the rough-and-ready, diamond-in-the-rough industrialist entrepreneur—epitomized by Andrew Carnegie—was on the wane.

J. C. Penney was born in 1875 in Hamilton, MO, the son of a primitive Baptist minister. As a young lad, Penney made money by raising hogs and growing watermelons and later managed a butcher shop. In 1902, at age 27, he bought a one-third interest in a retail dry goods store in Kemmerer, WY, where he was working as a clerk. He gradually expanded from that one store into a chain he called the *Golden Rule Stores*. Penney abstained totally from alcohol and tobacco and believed that every individual had the latent capability to become ". . . a human dynamo, capable of accomplishing anything to which he aspires. . ." Penney placed high emphasis on personal stamina and integrity. In 1908, his chain amounted to four stores with gross sales exceeding \$200,000. Three years later, there were 22 stores and gross sales exceeded \$1M. The chain grew late in Penney's life to 1,600 stores with annual gross sales exceeding \$4B.

Three success stories—all different, but with successful results. Richard M. Huber in his book *The American Idea of Success* argues that the development of volume production capabilities in this country changed the central thrust of business from manufacturing to sales. As a result, Huber continues, the U.S. idea of success also changed. American businessmen began to abandon the tenets of the *Protestant Ethic* (Huber refers to it as the *Character Ethic*) and began to adopt the *Social Ethic* which Huber refers to as the *Personality Ethic*. The result of this shift in focus—in Huber's view—was that the businessmen of the day began to report to their Boards of Directors and stockholders and ceased reporting to God. While this is a broad generalization, the era marked the emergence of sales as a major element of corporate business strategy.

Technology

The turn of the century marks the beginning of the entry into a new period in the quest for technological advancement. For the early industrial societies, it was the

beginning of second generation achievements—oil was replacing coal, the automobile was replacing the train, and electrical power was replacing mechanical power.

Inventors still sought mastery of matter and environment and responded to necessity, but they also saw—as Ludwig Mond, British chemist and philanthropist observed in 1889—that inventions “. . . may even create new wants. . .” This prophetic observation would mature to the fullest in the twentieth century.

Heavier-Than-Air Powered Flight

On December 17, 1903, at 10:35 a.m. with Orville Wright lying prone at the controls, the *Flyer* covered a distance of 120 feet in 12 seconds (an average speed of just under 7 miles per hour) at a desolate stretch of beach at Kitty Hawk, NC. Orville and his brother Wilbur took turns and made four flights that icy morning with Wilbur having the longest flight of the day at 59 seconds. In so doing, they achieved what man had sought for centuries and created a new machine that would become indispensable—in very short order—in peace and war.

The invention of the heavier-than-air flying machine was not accidental. Wilbur and Orville Wright pursued their objective in strict accord with disciplined engineering development methods. They read avidly on the subject, observed the flight of birds and deduced that their machine must have pilot-controlled, movable airfoil sections for stability and control, ran manned test flights (well over 1,000) with full-scale manpowered gliders, and built a wind-tunnel and tested more than 200 wing designs in order to perfect the design of their double wings. Since there was no engine available with a sufficiently high power-to-weight ratio, they built a 12-horsepower engine (developed at 1,200 RPM) that weighed only 170 pounds. They also designed and built the two propellers that were connected to the engine by means of bicycle chains.

Their work attracted little attention at the time. By the end of 1904 the Wright Brothers were experiencing sustained flight in excess of five minutes and could fly complete circles. Their machine was patented on May 22, 1906.

The step-by-step process used by the Wright brothers made their solution of the problem of manned flight appear to be far simpler than it was. Neither brother received a high school diploma, but theirs was a great technological achievement. The *Flyer* is on permanent display at the Smithsonian Institution in Washington, D.C.

Other Advances

Other technological advances of the first quarter-century of the 1900s include:

- Fessenden transmits human speech by radio waves for the first time in U.S. in 1900.
- The first transmission of a photograph by telegraph occurred in Germany in 1904.
- In 1906, Fessenden broadcast the first voice and music radio program in the U.S.
- The pride of British maritime and the largest vessel then afloat (46,328 tons gross)—the *Titanic*—sank on April 14, 1912 after striking an iceberg, with a loss of life of 1,513 people.
- The Panama Canal is opened to traffic in 1914.
- The first military fighter aircraft is constructed by Junkers in Germany in 1915.
- Westinghouse engineer Frank Conrad begins playing recorded music from his garage in Wilkesburg, PA, for the entertainment of his fellow ham radio operators in 1916. Westinghouse officials—seeing perhaps the radio's commercial future—erected the first radio station licensed by the Federal Government in October 1920. With its call letters still intact today, station KDKA broadcast the first coast-to-coast radio broadcast to an estimated 50 million listeners on February 8, 1924. The era of instant communication was born.
- Construction of 100-inch reflecting telescope at Mount Wilson, CA is completed in 1917.

The Decline of Laissez-Faire

The Age of Efficiency witnessed some of the best and of the worst of the products of the human mind. It arrived on a wave of *bigness* in business, in expansion of the western U.S., and in the pursuit of technologies that would create new needs and—in deed—whole new industries.

It was marred by the involvement of much of the Western World in World War I. At the outset, conventional wisdom of the day predicted a short affair of not more than a year—two at the most. The war began on June 28, 1914 and the

Armistice was not declared until November 11, 1918. The U.S. entered the war on April 6, 1917, by declaring war on Germany.

The technology advances of the period propelled humankind into the world of today. The moving assembly line and the most minute specialization of skills brought forth immense surges in productivity. Taylor and his disciples applied the scientific method to the problems of the factory and gained even greater productivity advances coupled with ever-narrowing occupational specialties. Business dynasties arose as huge production outputs resulted in large profits and much of the profit was injected back into the business.

The political element witnessed a decline in the laissez-faire attitude of the nineteenth century. Theodore Roosevelt took sides in 1902 and began invoking the Sherman Antitrust Act. Roosevelt became known as the *trust-buster* and thrust the Federal Government into the business of the business world. The Clayton Act of 1914 coupled with the Federal Trade Commission Act of the same year put more bite into the Sherman Act. In addition, with ratification of the Sixteenth Amendment in 1913, the federal income tax became securely anchored as a given for American wage earners and the passage of the Nineteenth Amendment in 1920 guaranteed female suffrage. The political thrust of the time was aimed at reducing the immorality of the laissez-faire market environment by striving for balance between business activities and the public good.

The economic factor saw a continuing shift from agriculture to industry in the economic baseline of America. Henry Ford's *Tin Lizzie* put America on wheels and gave almost everyone a new mobility never before experienced. Wages rose and the work week shrank. It dropped 5 hours to 55 hours per week in 1910 and another 5 hours to 50 hours per week in 1920. The financier entered the industrial world as the new man at the helm and sparked the change from the rough-and-ready titans of old to a smoother and better trained and more polished and more sales-oriented leader. Industrial efficiency hit new high water marks as America moved into the prosperity of the 1920s.

Taylor's *Mental Revolution* brought new meaning to the dignity of the worker. He believed—incorrectly—that the economic drive and rationality of man were his primary motivation and he sought harmony between labor and management through congruence of goals. The Progressive Movement sought the same kinds of ends and endorsed scientific management as a means. The Progressives were not against capitalism, but wanted greater balance between the interests of business and the public good. They argued that this could and would be achieved if business leadership was raised to the level of *statesmanship*.

The first quarter of the twentieth century was a unique mixture of diamonds-in-the-rough and polished gems, of laissez-faire and tightening government control, of peace and of war, and hit-and-miss and the scientific

method. For the primary purposes of this research, it was the period of efficiency and is best synthesized by the work of Taylor and his followers. While Taylorism may owe an intellectual debt to earlier systemic managers such as Towne, Metcalfe, and Halsey, it was far more refined and attracted far greater attention and usage. The eminent scholar, Henry Dutton, expressed the influence of Taylorism most succinctly when, in 1925, in examining the evolution of scientific management, he stated that "Its principles . . . have so merged themselves. . . with the general body of business practice, that we tend to overlook the extent of the revolution which has been wrought."

Human Relations

Taylor and his followers made many significant contributions to the field of management; contributions that were applied rather than theoretical and that provided solutions to the perceived pressing management problems of the early factories. The scientific management managers, however, have been criticized in later years because, it is argued, they tended to ignore the human element in the efficiency equation. While this criticism is not totally founded in fact, there is a discernable element of truth in such a judgement.

The work of the scientific management managers was based on two fundamental beliefs about workers: first, that workers were motivated solely by money and second, that workers were totally rational human beings that would subject any economic question to analysis and would always select the alternative that provided the highest economic return on investment. Both premises—in the minds of many scholarly analysts—suggest a limited understanding of human behavior and the vigorous importance of social factors in working life. As a result of these conclusions, these same scholars suggest that scientific management theorists viewed the worker as *economic man*; i.e. one that always seeks maximum economic return.

It was perhaps the initial emergence of these beliefs or simply an inherent interest in the behavioral aspects of working life and the ergonculture that sparked early interest in human relations. The engineers of the scientific management movement concerned themselves primarily with quantitative issues, but the social scientists concerned themselves with behavioral issues. Increased productivity was the goal of both the engineers and the behavioralists, but the focus of analysis differed.

Elton Mayo (1880-1949) is probably most famous for his participation in the Hawthorne Studies at Western Electric during the period 1930-1932, but he conducted earlier experiments in 1923 and 1924 at a textile mill in Philadelphia. Of specific concern in the experiments was the high labor turnover rate in the mulejenny spinning department. As a result of Mayo's changes in work patterns, the high turnover dropped dramatically, morale improved, and productivity increased.

The Hawthorne studies involved a series of experiments at the Hawthorne Works of Western Electric near Cicero, IL. The primary purpose of the experiments was to determine relationships between worker attitude and work performance. Lasting almost nine years and conducted in four phases, Hodgetts credits the Hawthorne studies as the single most important element in the foundation of the behavioral management approach.

These early investigations are frequently attacked as being insufficiently scientific and yet the results provided compelling insight into worker behavior in the industrial setting. These pioneering experiments extended the boundaries of knowledge and provided the impetus to incessant new discoveries in human behavior and industrial psychology.

Chapter 6

The Sociologic Era

Since the Industrial Revolution began, managers of plants have been concentrating on output, forgetting that under the factory roof is a human society, as authentic as that of a South Sea Island fishing village.

Stuart Chase

The Roarings 20s, the Jazz Age, the Dollar Decade, was a time of unparalleled prosperity in the U.S. It was a consumer economy filled with new products such as radios, electrical appliances for the home, automobiles, and the Hollywood films. The economy reflected this new age of consumerism by its use of mass advertising and installment buying. Big business continued its dominance of the marketplace, gave evidence of getting even bigger, and the Ford Motor Company made history again when it implemented the eight-hour day and five-day week in 1926.

Woodrow Wilson's views on internationalism stood in sharp contrast with the policies of isolationism expressed by Harding and Coolidge. America had emerged from the agony of World War I into a period of ascendance and was the richest nation in the world. In 1928, there were 26 million automobiles in use and annual sales of new cars approximated \$4M—there were 13 million radios in use in the same year.

Louis "Satchmo" Armstrong, Duke Ellington, Count Basie, and King Oliver dominated the Jazz scene as they brought the music of the South northward. Their arrival coincided with the mass sale of the radio and the development of an expanding network of broadcasting stations. The resulting synergism helped spread Jazz to the four corners of the nation as the flappers of the 20s responded to the new beat. Jazz was an expression of a new element of American culture—an element that symbolized a new liberty of expression. The pianist Thelonius Monk caught the spirit of the excitement when he said "Jazz and freedom go hand in hand."

As with many good things, there are sometimes negative forces that tarnish the glitter. The passage of the Eighteenth Amendment in 1920 made *dry* the law of the land and created an instant thirst for illegal booze and an overnight demand for the whiskey flask. Scarface Al Capone and others of his ilk went to work and organized crime became firmly entrenched in the U.S. But people differ. For some, the bootleggers were the heroes of the age—for others the villains

The rich got richer and the poor got poorer. Five percent of the U.S. population got over 25 percent of all annual income by 1928. Southern blacks, urban ghetto dwellers, and farmers didn't catch the glitter of the 20s and were—for the most part—wretchedly poor. Six months after Hoover, in his nomination speech, announced that we stood on the brink of final victory over poverty, the Wall Street Crash of October 24, 1929—BlackThursday—occurred and then the Great Depression swept the country and almost every other country in the Western World.

It was amid this mixture of false prosperity and real expansion followed by real depression and real bankruptcy that the Western Electric Company launched a series of experiments that would span almost nine years. Focusing on the social and interpersonal relationships of workers in the industrial setting, the Hawthorne Investigations are unparalleled in the history of industrial human relations. These investigations would form the basis for the assault of the emerging industrial sociologists on the earlier industrial psychologists.

The Hawthorne Investigations

The Hawthorne Investigations were conducted in the Hawthorne Works of the Western Electric Company in Cicero, IL from November 1924 through February 1933. The original intent of the investigations was to study the effect of room lighting intensity on the worker-intense output and also on worker fatigue in the miscellaneous punch press, receiver coil winding, and relay assembly departments. Wrege records that the genesis of these experiments was industry wide and that the purpose was to enable the electric industry to cause the final demise of industrial gas lighting, to increase sales of incandescent electric bulbs over the more efficient tungsten bulb, and to increase revenues in the electric industry. The tests were conducted under the auspices of the Committee on Industrial Lighting. The results of the initial investigations were so dramatically at odds with anticipated results—production *increased* as illumination decreased—that the results were surprised according to Wrege.

At this point, however, Western Electric tentatively concluded that no investigation of the industrial working environment would be effective that did not include an analysis of the worker in its scope. Since the company had launched the investigation using the scientific method, it was now faced with a formidable and totally unanticipated, inexplicable unknown element in the productivity equation. This factor had to be identified if the investigations were going to be of any value at all and hold up under rigorous examination.

Thus, an investigation that started out to be the basis for a significant competitive advantage by the electric industry turned momentarily sour and was of no value for its intended purpose. This allowed Western Electric to use the same management techniques established for the Illumination Investigations for subsequent experiemnts in the Relay Assembly Test Room.

Al Bolton, an executive with C&P Telephone, completed an extensive re-examination of the Relay Assembly Test Room study in the Spring of 1985. In his unpublished dissertation he points out that—contrary to popular belief—Homer Hibarger of Western Electric and not Elton Mayo of the Harvard Business School developed the procedures to be followed in the Relay Assembly Test Room investigations. Mayo—according to Bolton—entered the investigations after they were well underway.

Relay Assembly Test Room Experiments

The Relay Assembly Test Room investigations were prompted by the results of the illumination experiments. In the words of an executive of the company, the work "... grew out of a desire on the part of management to know more about their workers." These investigations ran the longest of all—five-and-a-half years—and are probably the most publicized and best known of all of the investigations. The Relay Assembly Test Room experiments were also the baseline from which all subsequent phases of activity evolved.

The Relay Assembly Test Room started in April 1927. One end of the main room was partitioned with a wooden divider to form the test room. It was equipped with a workbench and other equipment identical in form and layout to the department as a whole save one feature. The workbench had a hole in it with a chute attached to it. The completed relays were dropped through the hole as a means of recording outputs.

The relay assembly process consisted of assembling the telephone relay unit made up of small components. Assembly was done with the help of a jig and the final unit was held together with four machine screws. The total process was highly repetitive, of short cycle, and took just over one minute. Five assembly operators and a layout operator constituted the test group. Detailed records were kept of the output of both the test group and a control group.

The test group was monitored constantly by an observer. Among the records kept were logs of the conversations among the operators themselves (all happened to be female) that pertained to output of work rate. As the experiment continued, this practice broadened to encompass almost all conversation among the women regardless of topic. The detailed log entries, as a result, captured virtually all conversation among the operators that transpired during the workday.

During the period set aside for stabilization in the test room environment, no alterations were made at all in the working environment. This period lasted for five weeks and was designed to allow the workers time to adjust psychologically to what was thought to be a minor change; i.e. the physical separation from the main group. It was during this period, however, that a significant feature, that would come to be known as the *Hawthorne Effect*, came to light. The worker's output—from each of

the five girls—began to increase gradually without any change other than their physical separation from the remainder of the assembly room workers.

As the investigations continued, working condition changes were introduced on a predetermined schedule. Each alteration was introduced individually and allowed to run for a sufficiently long period of time—or so it was thought at the time—to stabilize its influence on the trend in output. The changes introduced into the environment included such factors as length of work week, length of work day, inclusion or exclusion of Saturday as a workday, and duration and frequency of rest periods.

Throughout the period of the test output rose from an average of 2400 units per worker prior to initiation of the test to over 3000 per worker per week. At this point, the primary conclusion of analysis of output trends was that there was virtually no consistent correlation between output levels or changes in rate of output, and any of the condition changes entered into the investigations. The output over the entire period of the test moved generally upward and exceeded the wildest estimates of the testers. Absenteeism among the workers in the test room dropped from a yearly rate of 15.26 days per worker to 3.56 days per worker which was significantly below that of the main room. In addition, sickness among the test group was one third that of the main room and there was almost complete absence of cumulative fatigue among test room workers. Further, company inspection records indicated a significant improvement in quality despite the increased output by the operators in the test room.

The most notable exception in these generally upward and positive trends occurred from January to July 1932 when the output of each of the operatives arched slowly downward and the test room was closed. The earlier zest of the operatives that caused the upward surge in output that so baffled explanation was replaced by anxiety born of an accurate sense of the severity of the times. The grip of the Great Depression tightened on the land and the relay operatives and the experiment assumed significantly lower priority as management struggled with more urgent concerns. Asked several years later to explain this phenomena, one of the operators said: "We lost our pride."

The Other Investigations

The Relay Assembly Test Room investigations ran continuously for almost six years from April 1927 to February 1933. Other investigations of far shorter duration ran concurrently.

The Mica Splitting Test Room was in operation from August 1928 through September 1930. It was patterned after the Relay Assembly Test Room methodology. It differed in two respects only. First, the operation of mica splitting differed from that of relay assembly. Secondly, the mica splitters retained their individual

piece-work incentive as the basis of payment during the experiments. The relay assemblers in the test room, on the other hand, were on a group piece-work incentive plan. Results paralleled those of the Relay Assembly Test Room investigation.

The Second Relay Assembly Group experiment ran for eight months only (August 1928 through September 1929). This experiment focused on retaining normal conditions, except that the operators were physically relocated to one end of the room. In addition, they were removed from the general group piece-work incentive plan and became a self-contained group. The presence of this special group in the department caused considerable friction with the other employees who also wanted special consideration. As the situation increased in severity, it became obvious that the experiment would have to be terminated, and it was. While no conclusive results were developed, the very situation that developed to such a level as to cause the termination of the experience was—in itself—a lesson in human behavior.

The results of the investigations led company and Harvard Graduate School of Business Administration personnel participating in the program to conclude that productivity increases were more a function of improved morale prompted by improved supervision rather than the changes in working conditions. This conclusion led to the Interview Program that ran from September 1928 through January 1931. The purpose of the interviews was to allow employees (over 20,000 were interviewed) to discuss, in confidence, with trained interviewers, any thoughts they had on any aspect of their employment or their working status.

The Bank Wiring Observation Room investigation resulted directly from the Interview Program. Early conclusions of the Interview Program suggested that group dynamics in a shop environment was a powerful influence on individual behavior.

The Bank Wiring Observation Room operated from November 1931 through May 1932. The experiment involved 14 male operators that wired connector and selector banks for telephone equipment. The group was moved to a room of its own, but was otherwise unchanged from standard working conditions. While the experiment lasted only a short time, the researchers were able to gather data that gave insight into work environment interpersonal relations.

Mayo's Role

George Elton Mayo (1880-1949) was an Australian and in his early career taught at Queensland University and later studied medicine at Edinburgh Scotland. He never received a medical degree, but while at Edinburgh, Mayo became a research associate in the field of psychopathology; the study of mental disorders. Mayo subsequently joined the faculty at the Wharton School of Finance and Commerce of the

University of Pennsylvania and then in 1926, joined the faculty of Harvard University as an industrial researcher. It was this position that propelled him into the Hawthorne Investigations.

Mayo first visited Hawthorne in 1928—for two days—and again in 1929—for four days—but it was not until 1930 that he and his staff became deeply involved in the investigation. Mayo and his colleagues were particularly instrumental in the massive Interview Program which produced a significant data base about employee attitudes.

Mayo is credited with having publicized the Hawthorne investigations into their position in the human relations movement. It is suggested by Roethlisberger that without Mayo's interpretations and analysis, the results of the studies ". . . would still be in the archives of the company gathering dust . . ." because nobody would have understood or appreciated their significance without Mayo's commentary.

Elton Mayo postulated that emotional factors were far more important in determining the efficiency of output of a worker than rational or logical factors. Within this wide spectrum of human factors that came into play in determining productive efficiency, interpersonal and intergroup participation were the most powerful in Mayo's view. Thus, Mayo opened up a bright, new, and vigorous dimension in industrial dynamics—a dimension that put the human side of humankind into the productivity equation. This new dimension emphasized the social in addition to the economic focus of the worker.

Mayo isolated the existence of a worker culture in the factory setting that could be examined using the scientific method. He postulated that the level of productive output was a function not only of the quantitative factors of production controlled by management but also of the worker's qualitative social needs and the level of their satisfaction, both in the factory and in their personal lives off the job as well. Mayo argued, therefore, that management must be based on a *sociological concept of group endeavor*. This was a call for Mayo and his intellectual heirs to *humanize the work environment*.

Hawthorne in Perspective

The Bank Wiring Observation Room investigation ended the actual experimentation at Hawthorne, but analysis of data continues to this day. The classical interpretation of the Hawthorne studies is that it was *the experiment* that serendipitously discovered the dominance of human emotion in the determination of human behavior. In almost all instances in the Hawthorne Investigations, emotion prompted worker behavior that was counter to the logic of the situation. The social factor in the ergonculture had been largely overlooked, but the Hawthorne studies—if nothing else—brought into sharp focus the existence of the

human factor in the equation. Man is much more than *economic man*—and the Hawthorne Investigations opened the door to new dimensions.

The Hawthorne Investigations are attacked as insufficiently scientific. These critics argue that the researchers were not scientifically open-minded and biased their interpretations of the results. Others contend that the Hawthorne Works was not typical of industry as a whole and was not a pleasant place to work in to begin with. It is also argued that the researchers did not pay sufficient attention to other factors that may have been at work such as individual motivational influences or corporate culture. These factors notwithstanding, the Hawthorne Investigations are the foundation for the human relations school of thought.

Hawthorne Revisited-Again

Hawthorne has been revisited on several occasions and probably will continue to attract scholarly attention. The data collected still represents a major milestone in man's quest for order and much of the original data is still available in Western Electric Company and American Telephone and Telegraph Company archives.

Al Bolton, in his 1985 work, interviewed some of the original participants in the investigations and has drawn some interesting observations. First, it has been suggested that the impact of having observers present caused the otherwise unexplained increase in output—the so called *Hawthorne Effect*. Bolton's interviews with several of the original operatives suggests such was not the case and that their presence had no effect. His second major observation is that "To say that money is not a major motivator would be an inaccurate conclusion to be drawn from the Hawthorne tests." Again, in his recent interviews, the strong suggestion that money *was* a motivator is present.

Bolton probably sums the findings of the Hawthorne investigations best in his final paragraph: "... interviewing the participants was a joy. It reaffirmed that these participants were, and are, real people—which is what the test discovered."

Additional Major Contributions

Much of the written work on management during the early days of the twentieth century focused on or was largely influenced by the scientific management movement. Four individuals, however, stand apart from this rigid mold. All made significant contributions to the theory of management and each had an instinctive sense of occasion. Their individual works are major milestones in the evolution of management thought. Two were Europeans whose work was not immediately recognized in the U.S., and two were native Americans with passionate personal views on management.

Henri Fayol

Henri Fayol (1841-1925), a highly successful French administrator and executive, documented the first theory of administration. He had a long and very successful career with one company in coal-mining and foundry work. His historic work, *General and Industrial Management*, was published in France in 1916 and first translated into English in 1930 and then again in 1949. His book was the result of his self-analysis of his own duties and responsibilities as a top executive. Fayol identified 14 principles of management that he had most frequently applied in his own industrial experience. These principles were neither exhaustive nor rigid, and were intended to demonstrate the conditions or groundrules of the management process. Fayol referred to his principles as *lighthouses* and suggested that they were to be adapted to individual circumstances.

Max Weber

Max Weber (1864-1920), a German sociologist, wrote extensively in a scientific sense in the social field. He distinguished between managers who were at the same time owners, and pure owners outside the management structure who exercised a wide degree of control over the managers by virtue of their control over financing and credit. For Weber, the separation of ownership and management was rational and permitted managers to be selected on the basis of qualifications of profitability. Weber identified three pure types of managerial authority as:

- rational-legal.
- traditional.
- charismatic.

He pointed out that these pure types were seldom found in history.

Weber also was a staunch supporter of the *Protestant Ethic* as the wellspring of the capitalistic spirit. Like Luther and Calvin before him, Weber emphasized that wealth was not to be pursued for its own sake, but was labor for the glory of God. Others have argued that the reverse was true. Notable among those with the opposite view is R. H. Tawney who argues that capitalism was the result of pre-existing economic factors and that Protestantism then followed from the capitalistic movement.

Mary Parker Follett

Mary Parker Follett (1868-1933) was a contemporary of Taylor's, but philosophically belonged to the sociologic era. Her work is representative of the human relations movement and reflects a deep interest in and understanding of human behavior. Follett was a political scientist and philosopher and was primarily

interested in the psychological basis of human activity and group interaction. Her management philosophy was founded on the grounds that man's motivational forces were the same on or off the job. She argued that the basic function of any endeavor was the coordination of group effort in a manner that produced the desired result in the most efficient manner. For Follett, coordination was the core of business activity. Although she did not refer to her view as a systems perspective, she clearly understood systems theory when she wrote: "The fair test of business administration, of industrial organization, is whether you have a business with all of its parts so coordinated, so moving close together in their closely knit and adjusting activities, so linking, inter-locking, inter-relating, that they make a working unit, not a congeries of separate pieces." She went on to say that inefficiency in business is typically linked to an imperfect coordination process.

Mary Follett devoted her career to the quest for organizational principles that would facilitate a baseline for disciplined progress of human well-being. Her philosophy was firmly grounded on the democratic way of life and held that it was necessary for all endeavors to strive sincerely for integration of all viewpoints—management as well as workers—so that all might be effective both in the group and in society as well.

Mary Follett is viewed by management historians as a true pioneer in the field. Her work stands as a linking pin between the scientific approach of Taylor and the humanistic approach of the human relationists. She also instinctively understood the essence of what is today referred to as systems theory and applied these precepts in the solution of management problems.

Chester Irving Barnard

Chester Irving Barnard (1886-1961), an executive of American Telephone and Telegraph, had a significant impact upon management theory, particularly with regard to organizational theory and human relations thinking. His total volume of written work is small, but he is quoted frequently. Sociologists frequently consider Max Weber the *Father of Organizational Theory*, but for many management theorists and practitioners that title belongs to Chester Barnard.

In his classic book, *The Functions of the Executive*, Barnard developed his theory of organization. He described formal organization as "... that kind of cooperation among men that is conscious, deliberate, purposeful." And then argues that executive capacity is "the most general strategic factor in human cooperation." This brings us to the core of Barnard's philosophy—that organization is a system of consciously and deliberately coordinated activities and the executive is the catalyst that makes it work.

Barnard believed that the executive had three vital functions in the operation of the organization:

- To provide a system of communication.
- To promote the acquisition of needed personal efforts.
- To formulate and define the objectives.

Barnard emphasized that it was critical that the individual be induced to cooperate in the organization. He believed that cooperative organization provided the potential for expanding the capacity of the group beyond those of the individuals. Barnard believed that the degree to which individuals contributed their effort to the organization or withheld it was a measure in their satisfaction or dissatisfaction with the organization. The organization was inefficient to the degree that individuals withheld efforts.

Barnard viewed organizational dynamics as a social scientist. His understanding was pragmatic and his book is a classic in the field of management. Although he did not use the term *discretionary output*, it is apparent that he understood its existence and potential.

On Value Added

Each of these four theorists held compelling views about the working environment, organizational dynamics, and the role of the individual. There can be no doubt as to the value of their individual contributions to the cumulative body of knowledge. Each was a pioneer in his or her own right and their works stand today as major milestones in the evolution of our ergonculture.

A Changing Perspective

The Age of Industrialization was spurred by technical minds bent on increasing productivity through mechanical advantage. The Age of Efficiency was guided by technical minds bent on increasing productivity through science in management. The Sociologic Age was driven by industrial behavioral scientists concerned with the human factor as it influenced productive efficiency. The behaviorists provided a different perspective than their predecessors on the importance of human emotion in the work environment, on the methods to be used to seek and secure worker cooperation, and on the role of supervision interacting with workers.

Hierarchy of Needs

Abraham H. Maslow (1908-1970) postulated a hierarchy of needs motivational model based on an underlying foundation that humans are *wanting* beings.

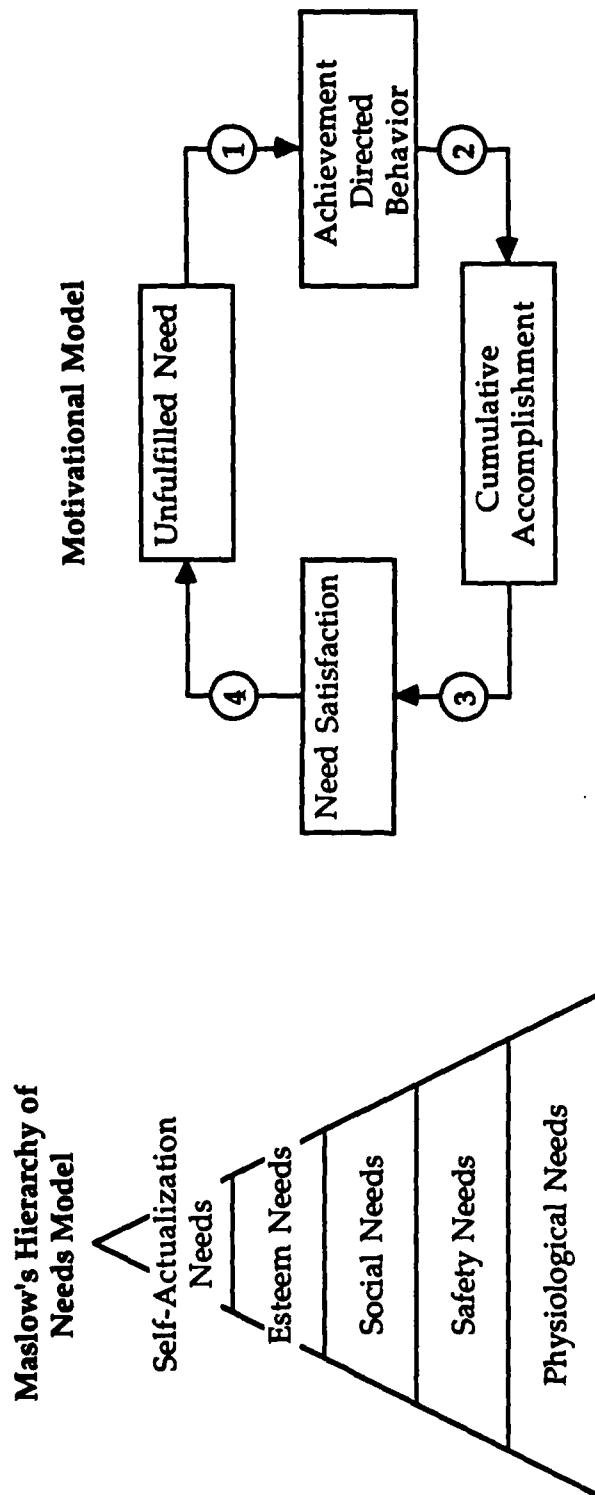
Further, Maslow argued that once a person satisfies a particular need, that need is no longer a motivator and the person moves toward satisfaction of another need. According to Maslow's theory, the needs are arranged in a broad hierarchy with lower level needs requiring some degree of satisfaction—not necessarily 100 percent—before the next level begins to assume importance. As a result, any individual might have varying degrees of fulfillment from the lowest level to the highest with lower level needs more fully satisfied than the higher levels.

Maslow's hierarchy is depicted at Figure 6-1 together with a simple motivation model. The lowest level needs in Maslow's model are physiologic needs. By Maslow's definition, these are the needs necessary to sustain life. Included are such necessities as food, water, shelter, and clothing. The next level—safety needs—are associated with protection from physical dangers, economic instability, and environmental instability such as a constantly changing work environment. The third level focuses on social needs and involves such needs as giving and receiving acceptance, involvement in interpersonal relationships, and affection. This is the *stroking* need that resides in all humans save perhaps avowed hermits.

The fourth need—esteem—is associated with the need to have a feeling of personal worth and to receive recognition. This need only surfaces when lower level needs are satisfied to some level, but it is vitally important. Everyone wants to feel that they are important and have a comfortable feeling of self-esteem; a *warm-fuzzy* if you will. The fifth and final level in Maslow's hierarchy is that of self-actualization. This is what Maslow described as the "... desire to become more and more what one idiosyncratically is, to become everyone that one is capable of becoming." This is the level of realization of maximum personal potential. In the words of current U.S. Army recruiting advertising, it is the *be all that you can be* level of need. It is the highest level of personal achievement possible in Maslow's hierarchy and is at the pinnacle of personal performance. This is the realm of high achievers and heavy breathers—the realm of those that use money more to keep score, than for the material goods and services that it can procure.

A simple motivation model is also depicted at Figure 6-1. The model is closed-loop and iterative—reflective of Maslow's needs hierarchy model. The model begins with recognition of a need with the level of the need depending upon the status of the individual in terms of total needs satisfaction. This recognition leads to achievement directed behavior as depicted by step 1. Once this behavior begins, its cumulative effect, step 2, continues until the need is satisfied, step 3. This satisfaction, in turn, awakens the individual's awareness to a higher level need, step 4, and another cycle starts again. While this is a simple model of human motivational behavior, it is nonetheless congruent with empirical evidence. It, like Maslow's hierarchy of needs theory, demonstrates the dynamic qualities of human needs and their satisfaction.

Figure 6-1 Motivational Concepts



It is the supervisor's responsibility to know which motivational button to push to secure employee collaboration.

Classic Incentive Plans

If the Hawthorne Investigations and Mayo's interpretation of the results, yielded a singular finding, it was that the human factor—the social factor—must be considered in the work environment and it must be considered in the group setting.

Two classic incentive plans that evolved during the period were the Scanlon Plan and the Lincoln Plan.

The Scanlon Plan was developed by Joseph N. Scanlon at the La Pointe Steel Company. Scanlon was a steelworker and union official and developed a productivity plan that provided workers with bonuses for savings in labor costs. The plan saved La Pointe from bankruptcy in 1938 and was appealing to the union because it helped save jobs and encouraged union-management cooperative interaction. The Scanlon Plan stressed cooperation in lieu of competition among employees and spread to other plants. It is still in use today in various forms.

James F. Lincoln, executive head of The Lincoln Electric Company, took a view different from the conventional wisdom of the time and—at least for his company—had an instinctive sense of occasion. He sought progress in efficiency through individual rather than group motivation. Lincoln stated the economy of his time presented ". . . for the first time in history opportunity and incentive for development to anyone who has the desire and will pay the price in effort." He clearly saw a change from prior relationships where man was a cog in the machinery of industry to a new view where machinery was viewed as just one result of the genius of man.

Lincoln referred to his method as *incentive management* and indicated that it was designed to develop the *latent ability* in the worker. He argued that latent ability was brought forth in selective situations through crisis and cited George Washington, Abraham Lincoln, Woodrow Wilson, and the 12 Apostles as evidence. Lincoln stated that had these individuals not been spurred by external conditions, their talents would have remained largely latent and unused.

With this argument as his supporting framework, Lincoln claimed that the latent ability is there and needs some catalyst to bring it forth. If latent talent does not develop, then man is ". . . usually only a shadow of his possible self." Lincoln's incentive management concept was the means of encouraging this development.

Lincoln's views have great attraction for the competitive. His plan offers both opportunity and incentive for those willing to put forth the effort. If longevity is a measure of success of an incentive plan, then *incentive management* is a success. Both it and The Lincoln Electric Company are alive and well as this report is written.

A Chicken for Every Pot

The phrase "a chicken for every pot" is attributed to Herbert Hoover during the 1928 Presidential Campaign, but Stuart Berg Flexner in *Listening to America* reports that Hoover never said it. Rather, it was attributed to Hoover by his Democratic opponent, Al Smith. Hoover did publish a campaign flyer and a newspaper ad that carried the title *A Chicken for Every Pot* from which Smith developed the slogan he attributed to Hoover. Whether *in* or *for*, Hoover won the election and the dubious distinction of being the incumbent president on Black Thursday—the day of the great Stock Market Crash—and U.S. entry into the Great Depression. Within scant weeks of the crash, 1.5 million people had lost \$30B and the U.S. ". . . had experienced the most devastating financial collapse in its history."

The Great Crash was the trigger, but the shaky economic foundation of the Roaring 20s and the amount and nature of loans to other countries were the real culprits of the Great Depression. It was catastrophic and plunged the U.S. into the longest economic depression in its history. The year 1933 was the Great Depression's worst year and by end of year, 4,004 banks had failed, one in every four workers was unemployed, and productive capacity was down by 44 percent of the 1929 level.

During the depression, enormous quantities of food rotted because the market was not profitable and yet millions were hungry. Wheat withered in the fields because harvesting costs were higher than market price while millions had no bread. Many factories stood idle because there was no market for their products and consumers could not buy because they were out of work. Dispair was prevalent, careworn faces the rule, and hardship a daily ritual. Soup kitchens and bread lines were symbolic of the harshness of the times.

New Deal

President Hoover rejected government economic control—the measure called for by today's thinking—and concentrated instead on a balanced federal budget; his program was hopelessly inadequate. Franklin D. Roosevelt, campaigning in the 1932 election sought other solutions since the depression was the only issue of concern. Borrowing perhaps from the earlier slogan of *Square Deal*, Roosevelt's reform package became known as the *New Deal*—and Harry Truman in the next decade would campaign on the slogan *Fair Deal*. Roosevelt promised aid to farmers, a balanced budget, public development of electric power, and government policing of the national economy, declaring in a San Francisco speech that "Private economic power is . . . a public trust as well."

In his inaugural address on March 4, 1933 (the 20th amendment to the constitution had not yet become effective), Roosevelt said self-confidently "This great nation will endure as it has endured, will revive and will prosper." During his first term in office his key recovery measures were to restore profitability to farming and to stimulate business enterprise. His first term saw such measures as:

- The establishment of the Federal Emergency Relief Administration (FERA) to grant funds to state and direct relief.
- The Civilian Conservation Corps (CCC) for reforestation and flood control. At its peak it employed 500,000 men.
- The consolidation of existing farm credit agencies into the Farm Credit Administration (FCA) to refinance farm mortgages.
- The Home Owners' Loan Corporation (HOLC) to aid homeowner's threatened by mortgage foreclosure.
- The Federal Housing Administration (FHA) to insure mortgages on new construction and home repairs.
- The National Industrial Recovery Act (NIRA) of 1933 to appropriate funds for public works under the Public Works Administration (PWP) and to administer industry fair practice codes through the National Recovery Administration (NRA).
- The passage of the Social Security Act of 1935 to provide unemployment and old-age insurance.
- The Works Progress Administration (WPA) for workers still unemployed to provide work and with it self respect and to curtail skill erosion. This program alone—by the end of 1935—had marked impact on economic recovery.
- The Wagner Act of 1935 created the National Labor Relations Board (NLRB) to adjudicate labor disputes for employed workers.

A quick review of these enactments—not encyclopedic by any means—reveals why they were referred to as *alphabet agencies*. The popularity of Roosevelt's programs and their positive affect on the hardships of the Great Depression were evident in his bid for reelection in 1936 when he carried every state in the then 48-state union but Maine and Vermont and received the highest proportion of electoral votes in over 100 years. Roosevelt took a firm hand at the helm when it was desperately needed and made the Office of the President an office of great power. The voters evidenced their support by electing him to an unprecedented four terms in office.

Union Activity

The Fair Labor Standards Act of 1938 supplemented the Wagner Act. It established minimum wage at 25 cents per hour with provisions to increase to 40 cents per hour in seven years. It also established the work week at 44 hours with provisions to lower it to 40 hours in three years, provided for time and a half for overtime pay, and prohibited labor of children under sixteen.

The Great Depression was a difficult time for small local unions. The AF of L grew and continued to absorb small craft unions. The craft union dominance of the AF of L opposed the thought of organizing unskilled volume production workers and bringing them into their federation. Eight of the AF of L unions, however, led

by John L. Lewis of the United Mine Workers, formed the Committee for Industrial Organization (CIO) in 1935 to encourage the organization of volume production workers.

The CIO was effective and quickly organized millions of workers particularly among General Motors and Chrysler auto workers, the rubber industry, and the steel industry. This success deepened the dispute within the AF of L and, after a series of internal actions, the AF of L suspended the CIO unions in 1938. The CIO then formed its own federation and changed its name to the Congress of Industrial Organizations. Thus, the AF of L kept its craft union dominance while the CIO became the federation of *industrial unions*. These two federations would again come together in solidarity in 1955, with some major realignment, and become the AFL-CIO (with the old AF of L dropping the of).

The Emergence of New Economic Theory

In 1936, John Maynard Keynes, British scholar and economist, published his text *The General Theory of Employment, Interest, and Money*. He soundly criticized classical economic theory and argued that it should be replaced with his new theory—to become known as *Keynesian economics*. Keynes argued that government ought to be active in maintaining the right level of aggregate demand in the market place in order to minimize unemployment and inflation. In his view, this was to be accomplished through dynamic fiscal policy that would replace the *laissez-faire* concept of Adam Smith. Keynesian economics held immediate appeal both because of his theoretical contribution and because of his personal persuasive powers. Although Keynes' original theories have been substantially refined, much of modern Keynesian philosophy is still traceable to his original concepts.

The Close of the Decade

The 1930s were brutish times in the U.S. The Great Depression bottomed out in 1933 and most economic indices began to improve. There is, perhaps, a continuing debate as to how much the *New Deal* should be credited for the improvements. The climb back was painfully slow and filled with misery for many. In 1937, Roosevelt himself said that one-third of the population was still "... ill-nourished, ill-clad, and ill-housed." In the October, 1938 issue of *The Yale Review*, the historian Walter Millis wrote that the New Deal "... has been reduced to a movement with no program, with no effective political organization, with no vast popular party strength behind it, and with no candidate." Roosevelt struggled to pull his party together and to maintain U.S. neutrality in the European conflict that would escalate into World War II. Somewhere in the ruthless rush of events of the turn of the decade, Roosevelt became—through necessity—more absorbed with foreign affairs than with domestic concerns. He would later call this his transition from *Dr. New Deal* to *Dr. Win the War*.

An Outraged Nation

Roosevelt sought desperately to maintain U.S. neutrality in the broadening conflict, but it became increasingly difficult. Roosevelt was aware that the Japanese were growing progressively hostile and Frank Knox, Secretary of the Navy, had predicted the possibility of a sneal attack on the Pacific Fleet at Pearl Harbor almost two years before that fateful day.

Pearl Harbor

It is difficult to understand why the U.S. fleet at Pearl Harbor was caught so ill-prepared. Roosevelt and his top officials had access to *Purple*, the code with which Toyko communicated with its consulate in Honolulu, and knew that U.S. fleet movements were being tracked. He also knew that the Japanese Government was at the point of breaking off negotiations with the U.S. that—the U.S. hoped—would spread oil on the troubled waters of the Far East.

The attack came on Sunday, December 7, 1941 as all but military sentries slept. The weather was clear and visibility good. In 110 minutes, three waves of Japanese aircraft sank six battleships, destroyed or damaged 347 U.S. aircraft, killed 2,403 U.S. citizens, and completely paralyzed the Pacific Fleet. The following day, the U.S. and Great Britain declared war on Japan while Germany and Italy simultaneously declared war on the U.S. Three days later, the U.S. declared war on Germany and Italy.

The attack on Pearl Harbor plunged the U.S. into World War II. It gave the country a common purpose and united its people in a common cause. It also precipitated the most massive production, build up, and flow of military armaments the world had ever witnessed and triggered the formation of the *Manhattan Project* of intensive nuclear research.

Arsenal of Democracy

The unprovoked and savage attack on Pearl Harbor triggered an explosive change in the cultural values of the nation. Twenty years of peace—including ten years of ferocious economic depression—beset a sluggishness of isolationistic detachment that would not, could not, and did not work in the shrinking globe of international politics. The American people were outraged by the attack on Pearl Harbor and became an arsenal of energy. The dominant American spirit surged forth at the gears of the *Arsenal of Democracy*—spun into action. Overnight, the U.S. realized national urgency, pinpointed national purpose, and solidified national resolve.

In the course of World War II, the Ordnance Department of the Department of the Army (DA) issued some 1,860 different models of major pieces of fighting equipment of which approximately 65 percent were models of new or improved design. The first contract for the four engine B-24 Liberator bomber, for example, was awarded in March 1939. The first flight occurred eight months later in October 1939. It was a highly successful program and the B-24 was produced in greater quantity than any other American war plane.

To say that this was superb performance is an understatement. Lt. Gen. Levin H. Campbell, Jr., Chief of Ordnance, DA, from 1942 through 1946, eulogized the *Industry-Ordnance Team* that performed this feat by portraying the Army's war record as "... an epic of industrial accomplishment which had never been equaled in the history of the world." Combat commanders usually praised the armaments and support they received, but there was occasional criticism mixed with the praise. On balance, however, the results were beyond expectations.

The manufacturing arsenals of the Ordnance Department were the *regular army* of production as the nation began to rearm in the 1939 to 1941 period. They carried the load almost single-handedly as American private industry tooled up to manufacture guns, ammunition, and tanks. The manufacturing arsenal concept was formulated by the Congress in 1794 to release the new republic from dependence upon foreign armsmakers. The concept worked very well and for many months during the defense build-up that preceded Pearl Harbor, Frankford Arsenal was the sole source of small arms for the U.S. Army and Springfield Armory was the sole manufacturer of the then new M1 rifle. In splitting orders between the arsenals and industry, the policy was to give industry as much work as possible. A second policy was that straight production was typically given to industry, thus freeing the more experienced arsenals to produce those articles not yet fully production proven.

Instruments of Innovation

Several innovations emerged very early in the conflict that are credited with saving the most precious of all commodities—*time*. One such innovation was the wide spread use of government-owned, contractor-operated (GOCO) facilities. Plants and facilities of this capability were needed quickly to make powder and explosives and to load ammunition. Since private industry works were not easily converted to these purposes, such plants had to be built by the government. The Ordnance Department recruited highly competent civilian firms to operate them and the venture was highly successful.

Another successful innovation was the establishment of a multitude of integration committees formed to break bottlenecks, speed production and promote cooperation among industries. These committees were fully protected from prosecution under antitrust laws. This innovation was particularly successful in the automotive industry and provided a forum where representatives of all

manufacturers of a specified product could discuss their manufacturing problems, exchange ideas, and arrange for quick loans of needed materials, machine tools, or production expertise.

Concept Formulation to Deployment

The time from concept formulation to deployment is long today and so it was at the onset of World War II. The American soldier went to war in December 1941 with equipment developed long before and indeed fought with it into 1944. But the national urgency, national purpose, and national resolve spurred by the immediacy of the war had a dramatic impact on that time-consuming process. Before V-J Day occurred, America and her allies were using a number of weapons such as the amphibious cargo and personnel carriers, proximity fuzes, homing bombs, armor-piercing-incendiary ammunition, and the bazooka that at the outbreak of direct American involvement were vague and unproven concepts. The late start and imperative for haste make these accomplishments all the more remarkable.

War Department Labor Planning

The War Department, by Armistice Day, 1918, to quote from its report on labor activities, had become "... a dominant factor in the industrial and labor situation." During the decade of the 20s emphasis was placed on procurement planning and the Army Industrial College was formed in February 1924 to train army officers in the acquisition duties and industrial mobilization planning functions specified in the National Defense Act of 1920.

Considerable attention was given to the concept of a universal draft of industrial manpower and for controlling prices, labor, and industrial resources in the event of war. Although a minimum of 10 bills of this broad nature were presented to Congress during the 1920s, none passed. Conscripting of industrial workers was not a popular concept—even in the event of war. Samuel Gompers, President of the AF of L, urged the War Department to consult with union officials on labor's vital role in wartime production as it had during World War I.

Efforts by the War Department to shed its image as a conscriptor of industrial workers were not totally successful. Except for a short period from 1929 to 1931 when Reserve Officers—who also were union members—were assigned to industrial mobilization planning and direct opinion of the AF of L was also sought, organized labor had no role in the development of industrial mobilization planning. Organized labor was suspicious of the planning and found it difficult to believe that such plans were based on labor's voluntary cooperation in time of war.

Mobilization planning continued and culminated in a 1939 plan. Reflecting nearly two decades of planning, the 1939 plan was not definitive as regards

mobilization of industrial manpower. As a result of the absence of a compelling explanation of the intent and scope of this issue, labor and the public became indifferent. President Roosevelt ultimately tabled the plan for reasons that can only be hypothesized, but not factually supported.

Although the Army's industrial mobilization planning was never formally implemented, much of the planning was implemented in pieces during the war. For example, the civilian War Production Board, National War Labor Board, and the War Manpower Commission resembled, in many respects, civilian agencies contemplated in the industrial mobilization planning blueprints.

Labor Experience

The War Department held a shadowy fear of a labor shortage and, in 1943, the shadow became reality. Although there were no general shortages at any time during the war, spot shortages of civilian labor at arsenals, Quartermaster depots, Engineer construction sites, and GOCO facilities became so widespread in 1943 that the Army became directly involved in industrial relations and labor supply. Prior problems involving finding workers for the transportation system in Seattle, for cotton growers in Arizona, and for the non-ferrous mining industry, had been handled by special project teams that were disestablished when the problem was resolved. Then, in 1943, a major manpower crisis developed on the West Coast in the aircraft industry and the Army implemented the prior ad hoc method as standard procedure.

Recruitment and turnover were the major elements of the problem and the steady drain of men and women into the armed forces escalated its severity. Thousands of workers on the West Coast that probably would have made a greater contribution to the war effort by building aircraft enlisted or sought voluntary induction. The competition for labor between the military services and industry was acute at this point as was the competition for workers between regional areas.

Prompted by forecasts that only 80,000 aircraft of a total of 95,000 scheduled in 1943 would be built due primarily to a labor shortage, all energies were directed at solution. While there was a significant amount of in-fighting involving the military departments, labor union officials, and private contractors, Director Byrnes of the Office of War Mobilization, issued a directive on September 4, 1943, that attempted to balance the competing interests of the War Manpower Commission and the War Department. The Byrnes' directive prioritized establishments on the basis of the importance of their contribution to the war effort, stabilized the labor force by allowing referral only through the U.S. Employment Service on the basis of the priority listings, transferred qualified registrants from lower priority to higher priority plants, and arranged for the Selective Service to give special deferment consideration to workers in occupations in critically short supply. Industrial recruitment efforts intensified and new workers were found through recruitment of

women, part-time workers, foreign labor, high school students after school, retired workers returning to the workforce, and movement of workers from other locations.

The Army method of special teams worked well and subsequent teams were formed to investigate specific industry-wide problems such as the ball bearing industry, the forge and foundry industry, and the tire industry; area-wide problems such as the West Coast problem; and specific company teams. Some friction with existing institutional machinery developed, but differences were generally resolved.

During 1944, victory came in sight although the road was still long. On the industrial front, there was fear that energies would begin to fade and that the shifting military requirements would further stir the problems of moving workers among industries. Production cutbacks were bitterly argued at all levels and disputes over policy engaged government officials, union officials, business leaders, and civic groups. The unconditional surrender of Germany on May 7, 1945, eliminated the problem and industrial manpower ceased to be an issue of major importance for the War Department.

World War II ended officially on September 2, 1945, when the Japanese signed the instrument of unconditional surrender aboard the U.S.S. Missouri in Tokyo Bay.

The Final Accounting

At wars end, American industry could properly share in the thrill of victory. Production had surged to unprecedented levels in unexampled leadtimes. No major flaws in the system could be conclusively traced either to production failure in spite of occasional spot labor shortages and arguments over policy or a failure of labor to put forth its best efforts. In terms of the purposes of this report, the most significant aspect of this amazing performance is that it was compiled over a 46-month period without *serious infringement of civil liberties of the civilian workforce*. It was accomplished totally through voluntary contribution of labor's cooperation and—in the author's view—the voluntary contribution of what the author describes as *discretionary output*. More will be said on this concept in the final chapter.

For the record, it is desirable to further quantify the accomplishments of the *Industry-Military Team* that responded so magnificently to the challenge. In panoramic sweep or in fine-tuned exactness, it was a challenge of dazzling proportions and complexity. The harnessing of American industry and production know-how began slowly, but shifted into high gear rapidly. World War II created a \$200B economy in the U.S. and resulted in permanent increases in rational productivity. When it was over, the wartime team had churned out the quantities of armaments depicted at Figure 6-2—a feat that still stands in silent testimony to the

Figure 6-2 The Arsenal of Democracy's Record

- 10 Battleships
- 27 Aircraft Carriers
- 211 Submarines
- 358 Destroyers
- 11,000 Other Warships and Cargo Vessels
- 64,546 Landing Craft
- 319,000 Artillery Pieces
- 296,429 Aircraft
- 86,233 Tanks
- 900,000 Military Trucks
- 12,500,000 Rifles
- 42,000,000 Rounds of Ammunition
- 2 Atomic Bombs

Almost without exception wartime needs prevailed over conflicts of interest and resulted in permanent increases in national productivity.

hard working and dedicated 55 million workers that committed themselves to the task of providing the weapons of war needed by the armed services of the U.S. and of its allies.

Perspective

The Roaring 20s to the final conclusion of World War II witnessed cyclic economic peaks and troughs of enormous amplitude. Those were strained times for the American people and many senior citizens today still carry heavy scar tissue—both mentally and physically—of the paralyzing, nagging self-doubt of the Great Depression and of the miseries and ravages of World War II. Some also remember with fondness and a warm inner glow the good times and prosperity of earlier days.

The war created new products, new markets, a more highly skilled workforce, and new concepts of volume production. The world globe was shrinking because of the airplane and management thought was in transition as a consequence of the Hawthorne Investigations and the wartime experiences. A postwar business slump was anticipated, but it did not materialize as business expanded and diversified.

Technology

Clearly the most profound technological advancement of the period was the controlled nuclear chain reaction. Albert Einstein, in an August 2, 1939 letter to President Roosevelt, pointed to the work of Enrico Fermi and L. Szilard in America and Joliot in France and alerted the President to the potential wartime application of uranium fission. Roosevelt set up an advisory commission and funded the project with an initial \$6,000. Basic research ended in May 1943 and the nuclear manufacturing facilities at Oak Ridge, TN; Hanford, WA; and Los Alamos, NM were constructed. The cost of the Manhattan Project climbed to \$2B. Humankind entered the atomic age at 0530 hours, July 16, 1945, in the desert of New Mexico with the detonation of the first atomic mass. At 0815 hours, August 6, 1945, the *Enola Gay*, an Air Force B-29, dropped the world's first atomic bomb on Hiroshima, Japan. The second bomb—the only other then in existence—was dropped on Nagasaki, Japan, on August 9, 1945.

An equally compelling, but perhaps less awesome, technological advancement occurred some years earlier in 1926 when Dr. Robert Hutchings Goddard (1882-1945), American scientist and rocket pioneer, achieved the first flight of a liquid-fuel rocket in the U.S. His interests in rocketry date to 1908. During World War I his work was sponsored by the Smithsonian Institution and later by the War Department. During World War II, Goddard did research on jet-propelled aircraft and the Army bazooka.

Other major technological advances during this period include such distinguished contributions as:

- Charles Lindbergh's solo, non-stop flight across the Atlantic in the monoplane *Spirit of St. Louis*. His flight took 33 1/2 hours on May 20-21, 1927, and instantly transformed him into a hero of epic proportions on both sides of the Atlantic.
- In 1935, Sir Robert Watson-Watt originated a methodology for aircraft detection using a radio pulse-echo reflected energy system. This *radio detection and range*—now known simply as *radar*—was put to first practical application in 1938 to guard the coastline along the English Channel. The design philosophy during those urgent times was uniquely captured by Sir Robert himself when he said: "Give them the third best to go on with; the second best comes too late, the best never comes."
- Igor Sikorsky demonstrates the VS-300, his first successful helicopter in 1939. The first helicopter that rose vertically into the air controlled by an on-board pilot was demonstrated by Louise Charles in France in 1907.
- In 1939, Howard Aiken, Harvard University instructor, began work on the machine that would become the modern ancestor of the digital computer. Aiken used punched card technology—first used on the nineteenth century Jacquard Loom—as the framework for data input to the machine. Completed and in operation in 1944, Aiken's machine could multiply two 23-digit numbers in six seconds.
- In 1939 also, humankind entered the world of synthetics. Developed by DuPont chemist Wallace Carothers from coal, air, and water, nylon was introduced to the world at the New York World's Fair. First used as a synthetic fiber in toothbrushes, the new fiber was woven into women's stockings and *Nylons* became synonymous with the word stockings itself. Nylon went to war in bomber tire treads and airplane parachutes. In the first year before the war, however, 64 million pairs of Nylons were sold to an eager female population. The DuPont plastic lucite was also introduced at about this same time.
- The concept of television was first postulated by Senlecq, a Frenchman, in 1877. In 1884, Nipkow, a German, proposed a simpler system. The idea was further refined in 1907 independently by Rosing in Russia and Campbell-Swinton in England and was again refined by Zworykin in 1925. The first demonstration by wire transmission occurred in 1925, with John Logie Baird demonstrating in England and Charles F. Jenkins demonstrating in the U.S. The first transmission using radio waves occurred in 1933, when RCA broadcast between New York and Philadelphia using a relay station at Arney's Point, NJ. Public television service was inaugurated in London in

1936. Full commercial TV broadcasting began in the U.S. in July, 1941. True commercialization of TV was delayed by World War II, but began in earnest in 1947. The first transcontinental broadcast occurred in September 1951 with the transmission of the Japanese Peace Treaty ceremonies in San Francisco. On November 18, 1951, Edward R. Murrow made his TV debut on a coast-to-coast hook-up and summed the potential of the medium by saying "No journalistic age was ever given a weapon for truth with quite the scope of this fledgling—television." Even Murrow probably did not foresee TV's potential in its business telecommunication role.

- First successful jet propelled aircraft flies in Great Britain in May, 1941. The design is that of Frank Whittle, English inventor.
- The electronic age arrives with the invention of magnetic tape in 1942.
- Use of V1 and V2 rockets by Germany ushers in the missile age in 1944.
- J. Presper Eckert and John Mauchly unveiled the first large-scale electronic digital computer—Eniac—in 1946.
- An American aircraft *Glamorous Glennis* with Captain Chuck Yeager at the controls exceeds the speed of sound in 1947.
- Transistor invented in 1947 by Bardeen, Shockley, and Brattain.
- U.S. explodes its first H-bomb on November 1, 1952, at Eniwetok Atoll.
- October 4, 1957, the Soviet Union launched the first successful space satellite—Sputnik.
- January 31, 1958, the U.S. Army launched the first successful U.S. Satellite—*Explorer 1*. The space race is underway and manned space travel within grasp. The same year, the National Aeronautics and Space Administration (NASA) was established to coordinate space activities. The brilliant Army team formed the core of technical expertise.

Political Element

The political trend was toward an ascending role of government in both individual and business affairs. Hoover was blamed for the Great Depression and Roosevelt's popularity was charismatic. His political administration endured for four terms although Roosevelt himself died in office during his fourth term.

Federal Government was concerned with labor issues and passed legislation accordingly:

- Railway Labor Act of 1926—imposed the use of collective bargaining and established mechanism for mediation.
- Norris-LaGuardia Act of 1932—regulated the issuance of federal court injunctions in labor disputes.
- The National Labor Relations (Wagner) Act of 1935—protected the right of labor to organize and bargain collectively.
- Labor-Management Relations (Taft-Hartley) Act of 1947—marked a new departure in labor relations by amending the Wagner Act and regulated a number of union administrative practices. The wartime regulation of labor tended to strengthen labor's power, but public sentiment turned in the aftermath of the many strikes following the war. The Taft-Hartley Act was an attempt to bring better balance of power between employer and labor.

It has been said that undistinguished American presidents are those who did not use the powers of their office, while great presidents provided purpose and direction to an expectant people during periods of crisis and transition. While it is difficult to provide a scale of measure, a poll of 55 historians in 1949 ranked Roosevelt the third greatest president in history behind only Lincoln and Washington. Hoover, on the other hand, ranked 20th, at bottom of the list of average presidents.

Eisenhower was swept into office by a landslide vote in 1952. He attempted a middle-of-the-road approach in his early years, but then began to push his own programs more vigorously. His domestic program hinged on a balanced budget, less control of the aggregate national economy, continuation of social programs, and an increasing share by private industry in the development of the nation's resources. In foreign affairs, Eisenhower called for a *new look* in national defense built on the capability for *massive retaliation*. Eisenhower used industry as a supplier of armaments and the relationship between the parties came to be known as the *military-industrial complex*.

The attempts at unification in Korea continued to command attention. The creation of two rival governments backed by two competing super powers and the military conflict during the early 50s were the focus of the issue in which no one came out a winner. The *Iron Curtain* of which Winston Churchill spoke in 1946 was much in evidence and the *Cold War* characterized East-West relations.

Economic Element

The scarcity of consumer products during the Great Depression coupled with the rationing of consumer products during World War II built in a bursting, latent demand for goods and services. America had to retool from military to civilian

goods at wars end and demand exceeded supply. Capitalism remained as the foundation of the American economic scene, but corporations found themselves increasingly controlled by public regulations.

Social Ethic

In a study of the *typical* American city of the late 1920s, Robert and Helen Lynd found different values between working class workers and white-collar workers. The working class workers appeared to be driven primarily by economic motives and equated social status with financial status. There was also a strong tendency toward individualism. The Lynds found, however, that there was a directly opposite trend with regards to need for group affiliation among the white-collar workers. They now were becoming more conformist and exhibited a high degree of interest in belonging to a group. In a follow-up study during the Great Depression, the Lynds found that the insecurity of the economic environment had forced all to reassess their values and had further separated the views of labor and management.

The Great Depression shook the branches and, in fact, the trunk of the Protestant Ethic and brought into question the lasting value of hard work and the sustaining virtue of thrift. Studies on the need for achievement made by David C. McClelland, the noted psychologist and Harvard professor, found that the need for achievement rose in the U.S. from 1800 to 1890, but has decreased from that date. He found further that between 1925 and 1950, the need for affiliation replaced the need for achievement as the more compelling concern. McClelland's later work suggests that it is possible to develop a high need for achievement in individuals through training.

Sociologic Concerns

The sociologic era was dominated by times that stressed the mind, body, and spirit of man. The events of the period changed our perspectives as we sought to check the excesses and harness the benefits of a capitalistic economy. More—not less—government was the thrust of conventional wisdom and humankind began to question the virtues of the Protestant Ethic and the compelling need for achievement. Those concepts just didn't seem to be as important as group affiliation and the feeling of belonging in the long scheme of things.

Management began to see this as well and turned increasingly toward the study of groups to more thoroughly understand human behavior and—in the industrial setting—to improve productivity. Mechanical efficiency was still vitally important to be sure and processes were understood to be at the foundation of a logical approach. But man was seen—perhaps for the first time—as more than a quasi-mechanical cog in the machinery of the factory. Man was emerging as the pivotal player in the working environment. Also—perhaps again for the first time—man

was viewed as a whole man that was at work much the same as he was at home. He had one personality and basic set of values and he had them 24 hours a day, seven days a week, not 8 hours a day, five days a week. When at work and when work is done, man is much the same man.

The world of management was becoming increasingly complex, but the efficiency and effectiveness of management thought was also on the ascendency. Instead of just correcting the mistakes of the past on a lessons learned basis, the molders of management thought began also to aim at strategies for handling the challenges of the future as well. A body of knowledge was beginning to accumulate that managers could use as a framework for action.

Management thought moved closer to the threshold of a full systemic approach to understanding that included all factors of production. Like movements before it and movements that will follow, the entry of the social scientists was not and is not the whole key to the puzzle, it is only a piece of the solution of the puzzle. It is a significant piece, however, because it was a key challenge to basic management assumptions prevalent at the time. The sociologic era—with its emphasis on human behavior—awakened our sense of the possibilities of what might be.

Automation Revolution

The automation revolution is already in the midst of its second computer revolution. The first computer revolution centered on the use of large computers—mainframes—by large organizations in both the private and public sectors. These early mainframes were huge, costly, required highly controlled physical environments, and were considered mysterious by all but the computer cultists. This first generation was dominated by the giants—IBM, Control Data Corporation, Sperry and the like—and nobody's peripheral equipment was compatible with anyone else's because plug-to-plug compatibility—fostered by Government unbundling decisions—was a thing of the future.

The second computer revolution focuses on small computers—minicomputers and microcomputers—and makes computing capability available to almost everyone. The minicomputer age was launched in 1963 when Digital Equipment Corporation introduced the PDP-5 and followed it two years later with the PDP-8 that was more powerful. In 1970, IBM sanctified the minicomputer boom with its System/3 entry. These early entries were unique because they demonstrated that computer size could be reduced significantly with attendant lower cost. While the early mini was not as powerful as the mainframe, the trend toward increasingly more powerful performance with dramatically improving processing speeds in small packages was abundantly clear.

The even smaller microcomputer had its genesis in 1971 when Ted Hoff, an engineer at the Intel Corporation, designed the first microprocessor—designated the Intel 4004. The first microcomputer was the Altair 8800, offered as a kit in 1975. Steve Jobs and Stephen Wozniak began work on the Apple in 1976, formed a partnership in 1977, and began manufacturing and selling Apples in significant quantities. The rest of the Apple story follows the path of the American dream. IBM again sanctified the age of the microcomputer with the introduction of the PC in mid-1981 and became instantly competitive with industry frontrunners. The microcomputer boom is intense and gives every indication of continuing at its frenzied pace. Commercially available software packages are becoming more and more numerous and more powerful and cover almost every imaginable data processing requirement. The introduction of electronic desktop publishing with capability for integrating graphics and text places production of crisp, professionally packaged reports within everyone's reach. The graphics software packages provide us the punch we need to speak vigorously through pictures.

The Automation Revolution is dominated by computers and information processing. It creates new relationships, causes us to understand information as a resource like never before, challenges us to advance information technology in new and creative ways, threatens to drown us in tidal waves of data, gives birth to potent hidden forces, consciousness in silicon, potential wide-spread use of artificially intelligent systems, increasingly substitutes machine control for human control, and places rapid data availability and interchange at the lowest levels of organization. We continue to extend the frontier of knowledge strengthened in our resolve by past accomplishments.

We are in the age of systems and the systemic perspective facilitates our integrated advancement on several fronts. Software advancements must keep pace with hardware advancements if we are to maximize their integrated utility. Continued aggressive analysis of human behavior in organizational settings will result in new insights on how to further elicit additional contributions from the discretionary capabilities that lie within each of us. Similarly aggressive analyses should be maintained in development of organization structures that complement computer-based systems and maximize their utility to productivity improvements. And, finally, we must pay greater attention to cultural changes and develop the ways and means of inducing beneficial cultural changes that will add greater zest, vitality, and meaning to working life.

Chapter 7

The Age of Systems

Craftsmanship is in the hands of the craftsman, not in the craftsman's tools—the electronic computer is a tool.

William C. Wall, Jr.

Our modern age is computer-based and many bright people argue that we are undergoing an Information Revolution—a revolution equally as compelling as the Industrial Revolution. The facts seem to speak for themselves:

- 75 percent of all information available today is 20 years or less old.
- The total amount of information doubles every 10 years.
- 50 percent of the workforce in industrialized countries is in information work.
- Some 70-80 communication satellites are in geosynchronous orbit—orbits that fix the satellite in space over the same location on earth—and can transmit the data equivalent of 10 million books daily.

The electronic computer is at the heart of the information revolution. It is both the creator of and the solution to the catastrophic explosion of information we have witnessed in the past several decades.

In May 1961, President John F. Kennedy committed the U.S. to a national objective of placing a man on the moon and returning him safely to earth in the decade of the 60s. On July 21, 1969, Neil Armstrong—his pulse beating at a phenomenal 150 beats per second—stepped from the Apollo II lunar capsule onto the moon's crusty surface. As he did so he said: "That's one small step for a man, one giant leap for mankind." Upon their successful return to earth, the \$25B Apollo Program had fulfilled the President's objective. The program is a testimony to the genius of man and is a prime example of the successful application of a computer-based systems approach.

The Systems Approach

The systems approach evolved from operations research—a methodology that emerged with the military needs of World War II. Operations research brought together many disciplines to wrestle with complex problems and focus on interrelationships among variables. It is a quantitative methodology that seeks acceptable—not necessarily optimal—solutions among competing objectives.

General Systems Theory

General systems theory was thrust into the limelight by Kenneth E. Boulding in his classic article *General Systems Theory—The Skeleton of Science*, in 1956. In his article, Boulding describes a hierarchy of nine levels beginning with the level of *frameworks* which relates to the anatomy of the universe and ends with *transcendental* systems which are related to social and human systems. The beauty of Boulding's theory is that it is founded on the principle that all phenomenology—regardless of location or scope—are interrelated in some manner. Boulding's theory built on the teachings of biologist and philosopher Ludwig von Bertalanffy.

Ludwig von Bertalanffy (1901-1972), is the recognized *Father of General Systems Theory*. Although he did not profess to have developed a theory, Bertalanffy reasoned that laws of biological systems applied to the human psyche, to social structures, and to larger systems. He saw all systems as *open systems* acting upon and being acted upon by their environment and attempting to attain a steady state or state of equilibrium. A Bertalanffian system is anything that is maintained by interaction of its components be it an organization, a human being, a strategic defense mechanism, an automobile, or a set of regulations. A system can be static like a gem, mechanical like a grandfather's clock, electronic like a computer, self-regulating like a thermostat, and organismatically interactive like populations.

Systems are hierarchic as discussed earlier. Depending upon the viewers perspective, what is a system to one may be a subsystem to another and a suprasystem to yet a third observer. The hierarchic nature of matter is a logical observation and in sync with our normal understanding of the universe around us.

Synergy

Bertalanffy observed that systems create synergy because they are greater than the sum of their parts. They derive this synergy because of the interrelations among the attributes of the components and the interrelationships among the components themselves. Bertalanffy's wholistic view meshes nicely with that of Aristotle who observed years earlier that ". . . the whole is more than the sum of its parts." In Bertalanffy's reasoning, the wholistic view was lost during the Scientific Revolution

because analytical experimentation was based on the isolation and observation of one element at a time. Thus, the synergy of interrelationships was omitted and science had *analysis* but was missing the critical function of *synthesis*.

The *Galaxy View* of General Systems Theory

The author, in attempting to put general systems theory in perspective for graduate students in the classroom, has developed a concept called the galaxy view. It goes like this:

Close your eyes and visualize a familiar image on the back of your eyelids for a moment. You are standing in front of a large blueberry blue shopping center locator board. You are searching for the *You Are Here* arrow in order to orient yourself. Instead of the usual styled floor plan with its maze of numbers and brilliant color codes, you see, in front of you, a drawn-to-scale artist's color rendition of our Milky Way galaxy with its 200 billion stars. The bold *You Are Here* arrow points to our star, the sun—smaller than a pinhead in the sketch of the 100,000 light year diameter galaxy (a light year is the distance light travels in one year. Light travels 186,000 miles in one second). You begin to ponder the interrelationship of our earth with the other 199,999,999,999 stars in the luminous swirl of the Milky Way. You see the big picture. You have just experienced the "galaxy view". This exercise will help you to visualize the big picture, to put ideas in perspective and to conceptualize relationships.

In the classroom the discussion is supported by a projected transparency of the Milky Way Galaxy, but the creation of the image on the backs of one's eyelids is equally effective.

Benefits

The principle benefit of general systems theory is that it provides the framework for examination of the whole in terms of its parts and focuses on the interrelationships among the parts. The full scope of interrelationships in the factory setting eluded the engineers of scientific management and only began to emerge empirically in the Hawthorne Investigations. Had both groups been sensitized to examining interrelationships, they might well have broadened the boundaries of their examinations and included additional relevant factors that

would have provided more penetrating insight into the true nature of target relationships.

A second benefit of general systems theory is that ethical beliefs must be integrated as a system and, therefore, there can be no such thing as the use of immoral means for moral ends. In Bertalanffian teachings, means and ends are identical. The system of beliefs must be integrated with the systems of will and skill in the working environment. Said another way, the ergonculture must be a composite of many elements as originally discussed in Chapter 1, for we cannot pick and choose only the elements of expediency.

Family Systems Theory

The systems approach has entered the world of psychoanalytic theory and its application has direct applicability to investigations in the working environments. Michael E. Kerr in his article "Chronic Anxiety and Defining Self" in *The Atlantic* points out psychiatric clinicians typically view patients from too narrow a scope of reference and—as a result—treatment is not as curative as it might be under a broadened perspective. Kerr indicates that this short coming is due to the lack of an integrative theory as a framework.

Kerr points out that an integrative theory still does not exist, but that an important step forward was made in the 1950s and 1960s by Dr. Murray Bowen, professor of psychiatry at George Washington, D.C. Given the descriptive label *family system theory*, it stresses the conceptualization of the family as a wholistic emotional unit with the individual—the patient—as an integral part of that unit. The family unit is viewed as an autonomous and integrated unit rather than as a collection of relatively autonomous individuals. Under the family systems approach the patient is studied in terms of the whole—the family—and psychological phenomenology and behavior are viewed in the broader and more meaningful context of that integrated relationship. Under the concept of psychoanalytic theory that viewed the patient only as an autonomous individual, object relationships were analyzed, but only as they were rooted in the psyche of the patient. As Kerr points out: "Traditional psychological concepts were seen to describe, rather than to account for, human functioning."

So too must it be in our examinations of worker behavior in the working environment. In this context, however, the examination must encompass an even broader scope of understanding than that described by Kerr. To be effective, the examination must include family, work, leisure, and all other major social groupings involved in the complex of interrelations of the *system* of which the employee is an integral part.

Cybernetics

Norbert Wiener (1894-1964) also built on systems theory and coined the word *cybernetics* to describe self-control in systems. Wiener theorized that all systems could be self-regulating by means of a feedback loop that communicated output data analysis to the input side of the system, thus allowing the organism to adjust to any changes in its environment. While the system in a mechanical sense may be likened to the furnace thermostat, Wiener was interested in feedback in man-machine interfaces from a human perspective.

Quantitative Techniques

General systems theory is the underlying framework for several quantitative techniques of postwar vintage that aid control and improve productivity. Such techniques as networking; line-of-balance; simulation; work breakdown structure; cost analysis; technical performance measurement; Cost/Schedule Control System Criteria (C/SCSC); and the Planning Programming, and Budgeting System (PPBS) are obligated to one degree or another to general systems theory. In addition, such tools as risk analysis, trade-off analysis, root cause analysis, and system engineering are dependent upon the concepts of general systems theory for their proper execution and implementation.

Modern Motivation Theory

In the previous chapter, we touched on motivational theory briefly by describing Maslow's hierarchy of needs. It is now appropriate to examine additional major theories.

Human Relations v. Human Resources

Human relations has in large measure given way to the more recent and broader view of human resources. The human relations view is an extension of traditional theories based on Judeo-Christian culture. As discussed earlier, the human relations view sought to deal with the *whole man* rather than just his contributions to organizational objectives. Further, the human relations view held that management had to help employees satisfy their need to *belong*—to be a part of the organizational team.

Miles in his *Theories of Management: Implications for Organizational Behavior and Development* points out that human resources views subsumed many of the principles of the human relations theorists, but extended them by arguing that "... many people want opportunities to develop and apply their full range of abilities

and to gain satisfaction from achieving demanding, worthwhile objectives." Human resources theory draws from the concepts derived during the 1930s and 40s—concepts that mushroomed following World War II. Miles sums the major difference between human relations theory and human resources theory by stating that the latter—in contrast to the former ". . . is aimed more at facilitating positive contributions than at controlling deviant behavior." Maslow's approach, discussed in the previous chapter, is perhaps the most prominent of the human resource motivational theories.

Vanessa Dean Arnold, in her article, *Motivation: Turning Theory into Practice*, sums the motivation thesis nicely when she states: "Motivation is not about the amount of effort: it has to do with the direction and quality of that effort."

Theory X/Theory Y

Douglas McGregor provided compelling insight into management philosophy in his book *The Human Side of Enterprise*. He believed firmly that ". . . the theoretical assumptions management holds about controlling its human resources determine the whole character of the enterprise."

McGregor divided basic management assumptions into two groups and developed a continuum between the two polemic extremes. Theory X assumptions were the traditional assumptions and held that:

- Humankind dislikes work and will avoid it where possible.
- Due to the inherent dislike for work, humankind must be coerced or otherwise forced to deliver adequate output in accomplishment of organizational requirements.
- Humankind seeks security as a primary objective, lacks ambition, and dislikes responsibility.

A grim view indeed, but one that McGregor insisted accurately reflected the views of managers in U.S. private industry. He stated that Theory X assumptions were not a *straw man* and that the bulk of management literature was based on Theory X assumptions. McGregor went on to say that managers holding these beliefs attempted only to satisfy physiological and safety needs and had made no provisions for satisfying higher level needs. He also observed that the reward typically offered by management—money for example—could only be used to satisfy worker needs after the workday was over.

Theory Y assumptions, on the other hand, provided the framework for a new theory of management:

- It is as natural to expend mental and physical effort in working as it is in leisure.
- Coercion and threat of punishment are not the only means of soliciting cooperation in the achievement of organizational goals. If/when committed, humankind will exercise self-control and self-direction.
- There is a direct relationship between the degree of commitment to organization needs and organization rewards tied to their achievement.
- Humankind learns to accept, and when properly motivated, to seek responsibility.
- Humankind generally has the capacity to develop and assist in the achievement of organization goals.
- The intellectual capacity of the average worker is being under used.

While Theory X assumptions are a harse reflection of humankind's nature, Theory Y assumptions are viewed by some critics as overly idealistic. McGregor also suggests that on-the-job motivation is the only kind that counts. That is probably not a totally valid assessment of the real world.

Finally, McGregor reasons that a Theory Y solution is the preferred solution, but that Theory X ". . . works reasonably well under certain circumstances." He argues that these conditions only occur, however, when physiological and safety needs are still motivators. It is this author's belief that Theory X managers in a Theory X situation are excellent managers as any U.S. Marine Corps. drill instructor at boot camp will attest to.

Two Factor Motivational Theory

Frederick Herzberg and his associates at the Psychological Service of Pittsburgh conducted extensive interviews in the Pittsburgh area to isolate the determinents of motivation. The interviewees were asked simply to identify job elements that made them happy or unhappy. Herzberg's analysis of the results of the survey and follow-up questions revealed two conclusions. First, when the subjects reported that they were unhappy and experienced job dissatisfaction, their negative feelings were attributed to their environment or job context. On the other hand, when the subjects felt good about their work and were happy, the factors associated with their positive feelings were attributed to the work itself or job content.

Herzberg labeled the job context factors *hygiene factors* and the job content factors *motivators*. In his analysis, Herzberg concluded that hygiene factors, when present, prevent dissatisfaction but do not act as motivators. In Herzberg's view, hygiene factors are preventive, but not curative. When absent, however, hygiene factors will result in worker dissatisfaction. Herzberg found many hygiene factors in the work environment such as physical working conditions, salaries, job security, interpersonal relations, benefits, company policies, and company administration. When these factors were present to an acceptable level, they prevented dissatisfaction but produced no increased output. When they fell below the acceptable level in the employee's assessment, job dissatisfaction resulted.

Motivators—in contrast to hygiene factors—could have a positive effect on job satisfaction and could lead to increased employee output. In general, these factors fulfilled needs envisioned by Maslow at the self-actualization level. Also referred to as *satisfiers* these factors included such things as the work itself, achievement, recognition for work well done, development and growth opportunity, and increased job responsibility. All of these factors were in job content and—when present—were motivators of increased employee output.

Herzberg's work has been criticized because his initial interviewees were a limited group in only two professions. Although Herzberg has broadened the scope of his interviews to other fields, other researchers have developed different conclusions. For example, some of the hygiene—also known as maintenance—factors such as salaries and job security were in fact motivators for blue-collar workers. In addition, additional examinations by other researchers have found that what is viewed by one employee in a department as a hygiene factor may be viewed by an employee in the same department as a motivator. The bottom line apparently must be a conclusion at this point that the two factor motivational theory is not a universally accepted concept and additional investigations and analysis are required before conclusive implications may be drawn.

Immaturity—Maturity Theory

Chris Argyris, while on the faculty at Yale, developed a theory based on his observations of industrial organizations. For Argyris there are basic trends in the development of an individual from infancy—immaturity—to adulthood—maturity—that follow a continuum. In Argyris' view, an individual progresses through seven distinct phases on the immaturity—maturity continuum as follows:

1. Passive state yields to increasingly active state.
2. Dependence state yields to independent state.
3. Growth from limited behavioral modes to multiple behavior modes.
4. Interests move from short term to longer term.

5. Time perspective grows from very short to longer with recognition of present, past, and future.
6. Growth from position of subordination to position of equality and superiority.
7. Ascendency from lack of self-awareness to self-awareness.

Having defined these stages along the continuum, Argyris argues that the typical organization keeps its employees in the state of immaturity. There are four reasons cited. First, specialization of labor limits personal initiative and leaves little room for self-expression. Second, the superior-subordinate relationship of most pyramid organizations establishes an immediate and formal dependency of those on the bottom to those above them. Third, the plan for achieving organizational goals is typically specified by the leader and leaves little room for expression of individual abilities by the employee. Fourth, the span-of-control of the superior is typically small thus allowing close supervision of employees and close control is automatically associated with immaturity.

Argyris contends that these factors tend to lead to routine jobs with little challenge and leave the employee with little control over the working environment. In this setting, employees tend to remain passive, dependent, and non-self-actualizing. This view is reminiscent of the *cog in the machinery* view and does not foster employee development. Under these conditions, mature adults find little goal congruity with the goals of the organization.

In order to combat these situations, management must move toward participative, employee-centered supervision and leadership and assist employees in their growth toward self-actualization. Argyris argues that management's response cannot be just eyewash. It must be genuine and aimed at attainment of true harmony in the working environment.

Argyris' conclusions are similar to McGregors and paint a grim panoramic view of management's assessment of the workforce. When management holds this view, it cannot possibly implement the proper motivational techniques.

Theory Z

There have been several proponents of theories labeled *Theory Z* the first of which probably is best attributed to Lyndall Urwick. The intent of Urwick's Theory Z was to fill two voids in McGregor's Theory Y. First, Urwick argues, individuals needed to understand the interrelationship between corporate goals and their role in achieving those goals. Second, employees needed to understand that when their achievements contributed to accomplishment of organizational goals, they would be rewarded.

John Morse and Jay Lorsch went *beyond Theory Z* and mounted an argument that a fit between managers, the nature of the work, and the characteristics of the individuals is necessary. Thus a theory X manager, in a theory X setting, managing theory X tendency individuals could be effective. The example of the U.S. Marine Corps drill instructor at boot camp is perhaps a good illustration of Morse and Lorsch's concept. Their theory works equally well at the theory Y level.

Perhaps the latest Theory Z is that of W. G. Ouchi, but it describes a type of organization and not a theory. It was an outgrowth of the American decline in productivity and our search in the Japanese culture for solutions. In his work, Ouchi developed three organizational ideals:

- Type A which was based on the American tradition of individualism.
- Type J based on the Japanese cultural heritage of consensus and groupism.
- Type Z was, in Ouchi's view, an emerging form that would be good for America as traditional methods of affiliation declined. Lacking affiliation in traditional sources such as family and other social groups, the employee would find needed affiliation in the working environment.

Ouchi soon converted the Type Z organization to Theory Z, but he was still talking about an organizational form rather than a theory. Ouchi did not view Theory Z as culturally limited and believed it would work equally well in industry of either the East or West.

Ouchi's Theory Z has been challenged. Critics argue that the Japanese industrial successes are more a reflection of vast cultural differences between East and West than pre-eminence in management styles. The Japanese cultural characteristics of collective decision making, strict obedience to authority, and group rather than individual responsibility are ingrained in the Japanese culture. These traits assure that Japanese employees fit a norm before ever arriving on the industrial scene.

Management by Objectives

No discussion of motivation and attainment of worker commitment would be complete without at least brief discussion of management by objectives (MBO). MBO was practiced at the General Electric Company as early as 1951 by Harold Smiddy, a long time GE Vice President, with Peter Drucker as a consultant.

In its simplest context, MBO consists of the formulation of objectives by management with the attainment of the objectives resting with the manager

responsible. Drucker argues that if the manager understands the objectives of the endeavor and his unit, then he should direct his own activities. Drucker replaces outside control with self-control and drive with achievement because the objectives require it, not because someone directs it.

Feedback regarding task accomplishment is based on predetermined and agreed upon goals and the more quantitative the better. Qualitative measurements are not to be overlooked for sure, but quantitative goals provide for a sharper measurement.

Ron Greenwood records in his book *Managerial Decentralization: A Study of the General Electric Philosophy* that "... subordinates play a major role in setting their own objectives and not in merely receiving objectives from above." Drucker never claimed to be the father of MBO, but again in Greenwood's words "... it took Drucker to put it all together."

Integrative Organizational Theory

Keith Davis in his classic *Human Relations in Business* helped differentiate between *organizational behavior* and *human relations*. The former, Davis indicated, focuses on empirical investigations that seek to understand, describe, and identify cause and effect of human behavior in an organizational setting. The latter addresses the implementation of these findings in the operative setting. In other words, for Davis, human relations is the integration of employees in the working environment in a manner that motivates them and provides them "... economic, psychological, and social satisfaction."

Integrative organizational theory is driven by the goal of synthesizing motivational methodologies into a fertile organizational environment. Two rather widely different approaches to this objective are contingency theory and sociotechnical systems.

While not a direct organizational synthesis, *contingency theory* provides a situational framework for the working environment that suggests that there is *no one best way*. Rather, actions are contingent upon the situation and the manager must make the best decisions possible consistent with facts existing at the time. Much like Barry Switzer, Head Coach of the Oklahoma Sooners football team, on the sidelines in the annual clash with Nebraska must make decisions based on the game situation of the moment, managers must do the same. Both are guided by past experience, resource availability, competition strategy, near term and long range objectives, and a host of other factors. When fully in command of the game situation—as he usually is—Switzer may react in one manner. On those rare occasions where the issue may still be in doubt, he will respond in another way. *It all depends* is the byword of contingency theory.

Contingency theory may or may not be a theory in its own right, but it is a fact of life. Managers must assess all variables, identify interrelationships and understand them, check contingencies at the margins, separate cause and effect—symptom and problem—and do what is best under the circumstances of the situation—it *all depends*.

Sociotechnical systems theory is based on the *open systems* concepts of Bertalanffy. Conventional physics viewed all systems as closed in that they did not interact with their environment. The laws of thermodynamics, for example, apply to closed systems. Bertalanffy, however, insisted that systems did interact with their environment: "An open system is defined as a system in exchange of matter with its environment, presenting import and export, building-up and breaking-down of its material composition." Open systems maintain a steady state condition with their environment at some distance from equilibrium. It is this difference between steady state and equilibrium that allows the open system to do work.

Sociotechnical systems theory was developed by the Tavistock Institute in Great Britain. The scholars of the institute—influenced by the open system concepts of general systems theory—applied them to social science concerns. Their approach underscored the systemic view and they studied production systems as a whole and in terms of interrelationships. They avoided the pitfalls of prior investigations that analyzed production operations in terms of isolated activities and examined both the technical and the social aspects of the working environment. As a consequence of this approach, the social aspects of human behavior were understood only in terms of the technical aspects and of the behavior of the whole system in interaction with its environment.

In sociotechnical systems, a given system—say a production assembly line—can only be accurately understood in terms of both its *technical* and *social* frameworks. This approach suggests that the examination of a production assembly line only in terms of its application of specialization of labor, the repetitive nature of the work, or the proper order of assembly is incomplete. In a similar vein, the human relationist approach that focuses primarily on group and individual behavior, incentive systems, and other psychological needs, are similarly lacking in investigative rigor.

The sociotechnical theory developed by the Tavistock Institute has been maturing since 1951. Empirical evidence has been gathered to support the theory in such activities as British deep-seam mining (the original study) and other production processes. Sociotechnical systems theory is still emerging, but it offers a conceptual baseline for employing a total systems to the examination and understandings of large-scale complex endeavors.

In Quest of a Theory

Wren perhaps sums the motivational theory tangle best when reporting that "... money has returned . . . as a motivational factor." Wren reports further that goal setting, job enrichment, and participation followed as motivators in that order.

Regardless of the conflicts in the theories, several points of commonality seem to bubble to the surface. First, people produce more in challenging assignments with goals that they accept. Challenge is in the eye of the beholder and to loosely paraphrase a famous statement by one of baseballs all time greats, Yogi Berri, *if it ain't challenging in the eye of the employee—it ain't challenging*. Second, people need feedback—open, honest, and accurate feedback. They must know how they are doing in the eyes of their superiors. They know how they feel about their progress, but they want, need, crave, and deserve feedback. Frequency is more important than formality, sincerity is more important than scope, and timing is more important than text. Finally, employees want to be rewarded for achievement and attainment of goals. The rewards may take many forms and obviously may be a mixed bag. In the final analysis most managers look to practice rather than theory and—in true keeping with contingency theory—do what seems to make sense at the time and under the conditions existent. They do what has worked before under similar circumstances, and that may be insufficient.

When management hopes for involvement and commitment from an employee, the desired result is an outlook and an inner feeling that the employee recognizes that his goals are the same as the organizations goals and that his abilities are contributing in a tangible manner to the achievement of organizational goals and to its success. A recognition that organizational success rests—at least partially—on the employee's efforts and that as the organization goes—so goes the employee.

Project Management

Project management is a productivity multiplier. It has been used in one form or another since the beginning of time. For example, it is hard to imagine the growth of the Great Pyramid of Cheops under any organizational strategy than project management. Similarly, it would seem that Christopher Columbus ought to be viewed as a fifteenth century project manager. He set the project goal, secured the funding, assembled the resources, and implemented his plan—all in the face of great opposition. Although he did not succeed in the accomplishment of his stated objective, his voyage to the new world was a victory of the determination and will power of a single individual in charge of his own destiny. Columbus had the instinctive ability of superior project managers—the ability to navigate in the unknown.

Concepts

Project management is a form of intensive management designed to focus management attention and control on complex endeavors. The term refers to the planning, execution, and control of a specific effort—a project—and the systems and difficulties employed flow from the nature of the endeavor itself.

Projects differ, but usually have certain fundamental characteristics that distinguish them for other forms of management:

- **Projects are Complex**—Projects are intended to produce specific results—either goods, services, or both—at a specific point in time and within a specified budget. They are typically new endeavors that are not repetitious of any prior activity.
- **Project are Multidisciplinary**—Projects typically employ the systems approach and require the application of multidisciplinary teams for their successful accomplishment. In this respect, project management is a formalization of the operations research methodology of World War II.
- **Projects Create Specific Results**—The products of the project management process are frequently more important than the process used to create them.
- **Projects Have a Life Cycle**—A project theoretically has a specific start date and complete date associated with a time line. A project matures along a continuum from concept definition to termination, but the separation of phases is rarely distinct.
- **Project Environment Changes Over the Life Cycle**—As the project progresses through its life cycle, the character of the organizational setting changes in terms of such factors as skill requirements, skill mix, organizational form, and non-human resource requirements.
- **Uncertainty Diminishes as the Project Matures**—The specified result and the resources required to attain it are inseparable. At the beginning of a project the uncertainties associated with technical requirements and time and schedule required to accomplish them are higher than at later periods in the life cycle. There are obviously exceptions and the author is aware of at least one major project in private industry that is and has been increasing in uncertainty as

the effort matures. It is a state-of-the-art project requiring as yet uninvited solutions.

- Acceleration Costs Increase Exponentially as the Project Nears Completion—Time is constant, but it is possible to *buy* schedule. This is easier to do and far less costly at the beginning of the project than toward the end. This characteristic makes good visibility and control systems an imperative in successful project management.
- The Importance of Design Decisions on Operational Effectiveness is Greatest at the Beginning of the Life Cycle—This is true of any design effort, but is especially true of complex projects. Early design decisions also have greater leverage on such other factors as product cost, product durability, and operating and support costs.

This list of characteristics is not exhaustive, but it provides a framework of understanding concerning the nature of the project environment.

Organization

Project organizations typically reflect a functional or a product-oriented framework. The organizational management is tailored to the tasks of the project, customer requirements, and parent organization policies. The form is far less important than the effect.

Projects typically are not totally self-sufficient in terms dedicated personnel resources. Because different skills and disciplines located in the support organizational structure contribute to the project, the project manager does not have the traditional authority commensurate with assigned responsibility. Project managers must interact with supporting organizations and provide project direction to individuals not reporting administratively to them. This disparity between responsibility and authority is a significant variant from traditional management theory and practice. It is a primary source of difficulty for both the project manager and the supporting organizations in effectively implementing the project and in achieving project objectives. It has led more than one project manager to question the lineage of the concept.

Methods

The methods of project management frequently reflect a systems approach. Projects must be planned, implemented, and controlled on a life cycle basis. Equal

attention must be given to managing both the product and the process of the project for both are important.

Visibility and control systems must provide for formal work authorization and control, accurate measurement of status, provide visibility of actual versus planned performance, provide for early detection or prediction of problems that require management attention, and provide the basis for variance analysis of differences between planned and actual performance.

In the final analysis, all methods are means to an end and should be so configured. Tailoring of methods among projects is not only permissible, it is normally advisable. The needs of projects vary and, within given corporate policy and procedure constraints, the tools used by the project should be consistent with its mission requirements and its ergonculture.

Defense Management

In July 1985, President Reagan formed the President's Blue Ribbon Commission on Defense Management under the chairmanship of Mr. David Packard. Charged with conducting a study of defense management including "... the budget process, the procurement system, legislative oversight, and the organizational and operational arrangements, both formal and informal, ..." The committee rendered its interim report on February 28, 1986. The committee took "... a broad and searching look at defense issues. ..." and charged itself with addressing "... the root causes of defense issues." One of its major findings was that "Control and supervision of the entire acquisition system—including research, defense, and procurement—can be strengthened and streamlined." The final report *A Formula for Action* issued in April 1986, cites a landmark Defense Science Board (DSB) study of 1985 as a source of solution. In the DSB study, the development of the IBM 360 computer, the Boeing 767 transport, the AT&T telephone switch, and the Hughes communication satellite are cited as private industry models of project management excellence to be emulated in the public sector.

The Blue Ribbon report specified the six underlying features that typified most successful commercial programs as:

- Clear command channels.
- Program stability.
- Limited reporting requirements.
- Small, high-quality staffs.
- Maintenance of effective user communications throughout program life cycle.
- Use of prototyping and testing prior to commitment to final design.

The Panel suggested that defense acquisition typically differs from this commercial model in almost every respect. The Panel strongly urged that the commercial model be used as a framework for DOD project management implementation.

Human Resource Development

Human resource development implies improvements—improvements in employee skill, knowledge, ability or willingness to contribute, in self-actualization, or in the ability to cope with change. Human resource development recognizes that the needs of an organization change over time and so do those of the employees. Organizations change as a result of modifications of mission responsibility, in response to organizational influences—both good and not so good—and as a result of technology changes. Individuals change as they mature along their chosen career paths and in the broader context of their *whole man* development.

These factors converge and demand that development be viewed from a systemic viewpoint if the organization is to remain competitive. Effective human resource development is assured when organizational needs are congruent with employee career aspirations and all parties work in unison. Development is a life long process and a vital element of a healthy and supportive ergonculture.

Quality of Work Life

A 1973 report of the U.S. Department of Health, Education, and Welfare, *Work in America* described many problems faced by today's workers. The HEW report cited increased specialization of labor, mechanization of jobs, and lack of worker control over on-the-job behavior were highlighted as major sources of worker dissatisfaction. The report called for urgent act to make jobs more *meaningful* and to improve the *quality of work life*. In a list of the ten worst jobs compiled in the mid-70s, such jobs as pool typist, copy-machine operator, and computer tape librarian were included with operator on assembly line, highway toll collector, and car-watcher in a tunnel.

A 1972 strike at a GM Plant in Lordstown, Ohio caught the eye of the nation because it dealt primarily with quality of work life issues. The plant was new, highly automated, had the latest technology, and an assembly line capable of producing 104 cars per hour in comparison with the industry average of 55 cars per hour. The plant workforce was 6,000 strong, and the average age of the workforce was 22 years of age.

This situation is interesting because the strike was caused by a speed up of the line by GM industrial engineers using methods founded in Taylorism. Unfortunately for GM, they failed to coordinate the speed-up with either the union

or the workers and the cessation of work resulted. O'Toole reports in *Making America Work* that secrecy of this nature is inherent in the GM corporate culture.

O'Toole also reports that an even more serious problem was occurring simultaneously at the older Tarrytown, NY Plant. After numerous attempts to solve the problem in its traditional authoritarian manner met with no success, GM tried involving the workers in the problem solution process with amazing results. The process worked each time it was applied because the workers were involved in the decision making process and responded positively. O'Toole reports that GM tried the method three times with success and then reverted to its traditional cultural values. Finally recognizing the futility of its old approach, it committed itself to a joint quality of work life project with the UAW in 1977.

Some of the more popular and better known quality of work life methods that have been tried include:

- Peer-established work rules.
- Creation of corporate training programs with employees doing the teaching.
- Task pay rather than hourly rate.
- Conversion of hourly wage earners to annual salaries.
- Sick-leave banks.
- Well bonus.
- Safety bonus.
- Quality control circles.
- Flexible working hours.
- Job enrichment.
- Job enlargement.
- Job sharing.
- Use of animals for selected tasks.
- Leisure sharing.

Humanization in the working environment might be the watchword of quality of working life activity. This is particularly true at the *operative* employee level where specialization has—in many cases—been refined to a very low level.

Team Building

Team building is an organization development approach that seeks to get employees to function with more effectiveness in a group situation. Tansik, Chase, and Aquilano indicate that team building activities in the business environment are typically aimed at four major organizational areas:

- Diagnostic Meetings—The diagnostic meetings are held to develop a

general assessment of team performance in the existing environment. Output of the analyses include such results as the team's strengths and weaknesses, team characteristics and capabilities, and identification of future areas for improvement.

- **Task Accomplishment**—This activity is aimed at developing the plan of action for achieving the sought after improvements identified in the diagnostic meetings.
- **Team Relationships**—This activity focuses on resolution of interpersonal or interunit conflicts and also on improvement of superior/subordinate and peer/peer relationships.
- **Team and Organization Processes**—This activity attaches to organization processes such as interpersonal and organization communication processes and media, organization decision making, and task allocation methodology.

Effective team building will improve communications, facilitate member interaction, and reduce dysfunctional behavior. The net effect should be an improved ergonculture and higher productivity.

Education and Training

Education and training activities are one of the older human resource development activities. The focus of this activity is the improvement of individual skills, knowledge, or abilities of employees.

These activities may include formal education at accredited institutions of higher learning such as undergraduate and graduate level schooling or technical training such as soldering certification, word processing, and computer proficiency training. Education and training may be afforded employees at the school's facility or on an in-house basis.

In-house seminars are becoming increasingly popular and cover a broad range of subjects from highly technical subjects to interpersonal skills. Requirements are usually determined by surveys, individual employee requests, and management generated requests. In most cases, the seminars are presented by trained professionals. In some cases, however, due to the esoteric nature of the material, employees are used as seminar leaders.

Career Planning and Implementation

Career planning by employees is a life-long process. Career plans may cover a projected period of two to five years or longer. The thrust is to help employees define their career goals, analyze their attractiveness, and then develop the means of attainment. The format for career planning varies, but essential information that ought to be included concerns:

- Individual inventory of existing skills, knowledge, and abilities.
- Inventory of prior experience.
- Statement of near term and long range objectives.
- Determination of training and education needs.
- Determination of rotational assignments.
- Determination of professional development activities such as publications, professional societies, and related activities.
- Plan of action with quantified milestones that depicts the planned course of goal achievement.
- Procedure for periodic joint assessment between employee and supervisory.

The Work Ethic

Unstable productivity is easily and quickly blamed on a faltering work ethic, but deeper analysis is necessary to arrive at root cause. A 1980 Gallop Poll, conducted for the U.S. Chamber of Commerce indicates that 88 percent of all working Americans believe that it is important to them personally to "... work hard and to do their best on the job. . ." The study concluded that the decline in productivity is not the result of a faulty work ethic. Quite to the contrary, the study identified a "... widespread commitment among U.S. workers to improve productivity. . ." and suggests that "... there are large reservoirs of potential upon which management can draw to improve performance and increase productivity."

Wherein then does the problem lie? A 1983 study by Daniel Yankelovich and John Immerwahr of The Public Agenda Foundation suggests that there is, in fact, a decline in work behavior, but it is not due to a decline in work ethic, but rather a conscious decision on the part of workers to give considerably less to their jobs than they know they are capable of giving.

In the study, only 23 percent of the study group indicated that they were performing to full capacity. In addition, 44 percent said they did not put much effort into their job beyond required minimum. The study also found that 62 percent of job holders believe that other workers are not working as hard as they used to.

A study conducted by D. M. Cherrington—reported by the American Productivity Center—over a two-year period found that only approximately half of a workers time was job-related. The other half was used up in coffee breaks, personal activities, waiting and idle time, and arriving late or leaving early.

There is also some indication that sexual harassment is a productivity killer. An article by Eileen Putman, Associated Press Writer, indicated that "Sexual harassment is pervasive within the Federal Government and cost an estimated \$267M, mostly in lost productivity, over a recent two-year period. . ." The subject of the article was a report of the U.S. Merit Systems Protection Board that indicated that 42 percent of women and 14 percent of men responding to a survey covering May 1985 to May 1987, experienced some form of sexual harassment. The survey was sent in March 1987 to a representative sample of approximately 13,000 permanent, full-time federal employees and 8,523 responded. A similar survey in 1980 found 42 percent of women and 15 percent of men reporting sexual harassment.

If Americans want to do their best on the job, but are performing at a lower level—in an environment that increasingly gives them more discretion over their output—the reasons must rest with management. In other words, the more liberal discretionary policies that underscore employee work ethic also call for revised management practices and management has not kept pace. Employees do not see a direct relationship between performance and reward. In the Public Agenda study 45 percent of the employees indicated their belief that there is no relationship between performance and pay. In addition, only 13 percent believed that they would benefit directly from harder work while 48 percent believed that such benefits would go directly to the employer or be equally shared by employers and employees (29 percent).

The study concludes that employees like and respect their managers in general, but 3 out of 4 indicate that their managers do not know how to motivate employees. These same employees also put the blame for the erosion of work behavior squarely on the shoulders of managers and management policy and practice. If the study is correct, the ball is in management's court.

Other Considerations

Change is a way of life in today's business environment. Organizations must function as open systems and influence and be influenced by their endogenous and exogenous environments. Planned change is proactive and assures that the human resources of the organization remain competitive, cooperative, and constructive.

Human resource philosophy differs from earlier human relations philosophy and the distinction is significant. Human relations views the business environment as a social system with employee motivation and behavior largely controlled by the

human interrelationships in that social system. Human resource philosophy—on the other hand—underscores a broader systemic view that suggests that employees want to be treated well in the working environment and also want to contribute in a significant way to organizational solutions. As Hodgetts so aptly synthesizes the difference, "... the human relations philosophy of treating people well ... has been replaced ... by a human resources philosophy of using people well."

Automation

The author finds it difficult to believe that there was an *age before radio*—the author's children find it hard to believe that there was an *age before television*—and the author's grandchildren, when they arrive, will find it difficult to believe that there was an *age before automation*.

Electronic Data Processing (EDP)

For perhaps the first time in history, management found itself in the position of having a synthetic aid in advance of practical applied theory for its use. Electronic data processing was a tool developed not for management per se, but for scientific endeavors. The instant challenge was to develop the means of harnessing this new heuristic and cybernetic tool and successfully integrate it into evolving management theory and practice.

One of the earliest management applications, of course, was in the comptrollers office where the new machinery was used as a number cruncher. A more imaginative early application was the development of various networking techniques. The line of balance (LOB) technique was developed in 1941 by George Fouch of Goodyear Aircraft as a graphic form of depicting the essential processes of repetitive production from receipt of raw materials to completion of the product against a planned delivery schedule. Almost 50 years old, this technique is being used today to track U.S. Army implementation of the Intermediate Nuclear Force (INF) Treaty with the U.S.S.R.

Additional networking techniques such as Critical Path Method (CPM) developed in 1955 by DuPont and the Univac Division of Remington Rand and Program Evaluation and Review Technique (PERT) developed in 1958 by the U.S. Navy in a joint effort with Booz-Allen & Hamilton and Lockheed Aircraft Corporation were naturals for the new EDP equipment. Not only were managers better able to plan and control large projects, but productivity improved as well because manual functions were replaced by machine functions.

Management Information Systems

The rapid shift to development of real-time and required-time large-scale integrated management control systems began in the 1955-60 timeframe. The general intent of most of these early systems was to integrate the planning and control functions in order to provide management with accurate, timely, relevant, and summarized information across the total spectrum of corporate interest. An added feature of early systems—a feature we now take for granted—was the attempt to provide impact prediction capability in order to assess future actions, determine probable impact of future possibilities, and provide rational alternative courses of action. This *what-if* or *simulation* capability was more advertised than produced, more dream than reality, in early applications.

Emphasis was also placed on new methods of integrating and controlling cost and schedule data in military and aerospace applications. Introduction of the Planning, Programming, and Budgeting System (PPBS) by Dod in the early 1960s and the Cost/Schedule Control Systems Criteria (C/SCSC) in 1972 are examples.

In the current environment, these early tentative steps are reflected in sophisticated, off-the-shelf software packages that are compatible with mainframe or PC machinery and perform miracles that were only dreamed about in the 1960s. Their contribution to the productivity of managers concerned with planning and controlling large-scale, complex endeavors is unmeasurable. The technologies of the computer, telecommunications, and office automation in the decade of the 1980s has resulted in the creation of whole new groups and departments, unparalleled capital investments in computer hardware and software, a need for computer literacy like never before experienced, and installation of computer-based systems that affect how the organization operates and how it competes.

CAD/CAM/CIM

It is natural that this machine—designed originally to do scientific work—would find application in the production arena. Computer Aided Design and Manufacturing (CAD/CAM) is creating the factory of the future in the present—CAD is replacing the drafting board with a cathode ray tube screen and CAM is replacing the numerical control tape with electronic digital control. CAD/CAM, coupled with such other recent developments as industrial robots and fiber optics, are at the hub of Computer Integrated Manufacturing (CIM)—the modern automated factory. With the flexibility offered by these new techniques, it is possible to produce a handful of items as efficiently as it is volume quantity.

Office Automation

Office duties were an early consideration for electronic conversion because they are repetitious, time-consuming, and labor intensive. A wide variety of office automation equipment including word processors, desk-top publishing systems, electronic mail, teleconferencing devices, and comparable software packages are on the market and prices tend to be decreasing in some areas.

Office automation may be viewed as a connecting link among managers. Word processing is now the standard for written communication; the electronic calendar provides a means for scheduling time quickly and conveniently; electronic mail and voice mail eliminate wasted time and provide for delayed contact on either a formal or informal basis; hardcopy data is available from document data bases and can be transmitted electronically in digital form; and teleconferencing is reducing travel costs by virtue of its immense flexibility. Properly done, office automation may integrate directly into the corporate MIS.

Artificial Intelligence

Artificial intelligence, as an area of investigation, is perhaps 30 years old—artificial intelligence, as a familiar field of study is much newer. By today's definition, AI encompasses the areas of expert systems, natural-language interfaces, voice recognition, and machine vision. In terms of its potential impact on our culture, AI is mind-boggling. Coupled with the immense speed and power of the modern computer, AI represents a formidable tool for mankind. In diagnostics, for example, expert systems will bring to bear the wisdom of the ages on all types of behavioral issues, interpersonal relationships, and motivational concepts. Artificially intelligent systems will be woven into management information systems and provide greater insight into program management simulations, will multiply the leverage of proactive management techniques 100-fold, and will contribute more to the decision making process by *anticipating* what the user is trying to accomplish. Expert systems in particular will provide synergy in word processing, spreadsheet, and data base management applications.

At one time, the development of artificially intelligent expert systems was a painstakingly slow process requiring dendritic analysis and development of detailed *what if/then* scenerios. It is now possible—with AI shells—to provide AI systems on a do-it-yourself basis by building them over a period of time with live data. While not as sophisticated perhaps as *expert system* programs, AI shells offer an affordable alternative.

As exciting as electronic data processing is—with all of its marvels of recorded accomplishments and all of its promise for future achievements—artificially intelligent systems, coupled with the genius of humankind, suggest the potential

that will allow us to fully explore the last three remaining frontiers—outer space, the deep seabed, and the human mind.

Contemporary Information Technology

Information technology is an emerging discipline in the information revolution. It is involved with the management of computer-based communication, office, and management systems.

The information explosion is real. Figure 7-1 graphically depicts the doubling of volumes in the Library of Congress from 1933 to 1966, a second doubling in 1979, and a third in 1987. Concurrent with this explosion is the rapid growth of new products, increasing internationalization of business, and greater competition on all fronts.

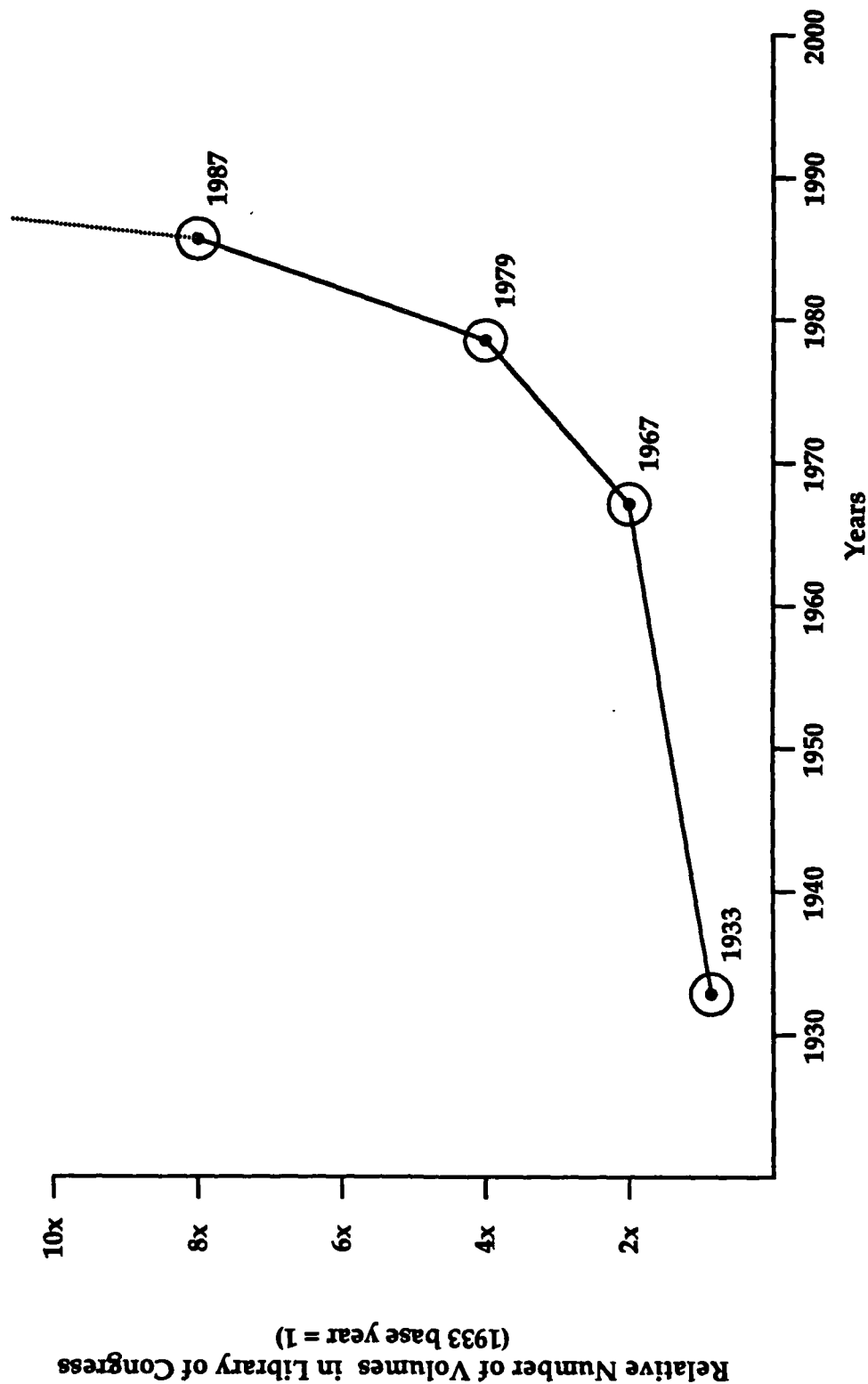
Information technology must be integrated into the business and is influenced in large measure by corporate culture. How senior management views information, their approaches to strategic planning, their corporate policy on visibility and control systems, the corporate value system—all are vital determinants of how information technology is implemented within the organization. Furthermore, it is not a static and rigid technology, but one of dynamicism and situation. The world of information is undergoing rapid and sustained change. Management of information technology must keep abreast of the changes or it will become increasingly dysfunctional and productivity will suffer accordingly.

It is a sad postscript to a glamorous field, but the computer *software virus* epidemic is emerging as a major threat to information processing of international proportions. Computer viruses are devastating productivity killers because they disrupt normal operations, erase data, and raise serious concern about the vulnerability of data processing systems everywhere.

Computer viruses—like their biologic counterparts—reproduce perfect copies of themselves and infect disks, hard disks, speed up disk drives so they deteriorate sooner, and can be transmitted by telephone lines. It is estimated that there are 3,000 electronic bulletin board systems in operation and many have been infected. It is only a matter of time until a killer virus penetrates a major electronic funds-transfer system and creates national—perhaps international—havoc.

A *Time* article by Philip Elmer-Dewitt indicates that more than 25 different strains have been separately identified. What is interesting and frightening is that viruses reside harmlessly dormant in some systems while attacking viciously in others. Triggers may be computer clock time, contact with a specific computer program, or other phenomenology. One of the most sophisticated viruses is known as the *Pakistani virus*—because of its origin—and was created by a disgruntled software programmer. Amjad Farooq Alvi, 26, developed the virus because a

Figure 7-1 The Information Explosion



proprietary package that he developed was copied and used illegally. He created the virus to *infect* bootleg users and force them to contact him for cure. The results of viruses can be trivial or as destructive as a virus that flashed the word *gotcha* as it totally erased entire disks.

The cure to the spread of the epidemic is simple—users should not copy disks or software, should use only original producer's copies, and should not let unauthorized users use their computer. Putting this cure into operation—particularly in big organizations—may be next to impossible.

Emerging Patterns

The closer one gets to today's dateline in a historical assessment of the nature of this report, the more difficult it becomes to accurately position events into proper perspective, to determine their true relevance, and to sort out their webs of interrelationships. This chapter sketches the highlights of the most significant events and what may be emerging trends and influences. It is not encyclopedic and may have omitted a work, activity, or event that—in years hence—will be viewed as a significant trigger or as the entry into a new cultural framework. Investigating what turns people *on* and *off* about working and how they feel about job satisfaction and productivity was spurred by the Industrial Revolution. These same concerns were revitalized by the advent of scientific management and volume production, were elevated even further by the Hawthorne Investigations and World War II, and now ascend to yet greater heights because of the automation revolution.

We are still struggling with the concerns for the technical and social frameworks of human behavior. The student unrest of the 1960s gave us sharper focus on the questions of the quality of working life and the broader topic of the meaning of life itself.

The interest in productivity was renewed as we faced greater competitive challenges than ever before, witnessed significant shifts in the balance of international payments, witnessed increasing inflation, and faced the threat and reality of recession. President Ford crystalized the growing national concern in the 1970s in an August 30, 1974 speech when he said:

Productivity must improve if we are to have a less inflationary economy It is essential in creating new jobs and increasing real wages. In a growing economy, everyone—labor, management, and the consumer—wins when productivity expands.

The methods and strategies for increasing productivity are within our competence.

Technology

Perhaps no other single machine in the history of civilization has so rapidly changed our culture. Computers have and are contributing in the world of technology, in the world of business, in politics, and in our everyday lives. Allis-Chalmers Manufacturing Company used to advertise—and perhaps still does—that their product line was so extensive that it was impossible for an average American to go through a single day without coming in contact in some fashion with a product processed by Allis-Chalmers produced equipment. Clearly a similar statement could be made today—it is impossible for the average American to go through a day without coming in contact in some fashion with a product or a service that is computer controlled, designed, processed, or supported. Computers are woven into the very fabric of our daily lives and gains in versatility, power, and microminaturization are being marketed with dazzling speed.

Special moments in technological achievement were as follows:

- A galaxy 6,000 million light years away is photographed at the Mount Palomar Observatory in 1960.
- The Russian astronaut Yuri Gagarin becomes the first man in space in 1961. He is followed quickly by American Alan Shepard.
- Zeus Missile—launched from the Kwajalein test site—intercepted and theoretically destroyed an incoming ICBM nose cone hurled into trajectory by an Air Force Atlas missile launched from Vandenberg Air Force Base in July 1962. U.S. has *hit a bullet with a bullet*.
- In 1962 John Glenn—the first American to orbit the globe—makes 3 orbits in Friendship 7.
- U.S. Ranger 7 reaches moon in 1964. Two years later the U.S. Surveyor I makes a soft landing on the moon.
- Then Secretary of Defense Robert McNamara announces decision to proceed with limited ABM development on September 18, 1967.
- Then President Nixon announced reorientation of ABM Program on March 14, 1969.
- President Kennedy's national challenge is triumphantly fulfilled on July 29, 1969, when Neil Armstrong and Buzz Aldrin land on the moon from Apollo 11.
- Boeing 747 goes into service in 1970.
- The Strategic Arms Limitation Talks (SALT) between the U.S. and the U.S.S.R. culminate in the limitation of Antiballistic Missile Systems (ABM) Treaty on May 26, 1972.
- Safeguard BMD System deployed at the Stanley R. Mickelson Safeguard Complex, Nekoma, ND on September 27, 1974. It was terminated on February 10, 1976.

- In 1977, the Royal College of Physicians' Report on smoking suggests every cigarette shortens an habitual smoker's life expectancy by 5 1/2 minutes. U.S. research would ultimately lead to the prohibition of smoking in many federal and private sector office buildings in the 1980s.
- U.S. Voyager I flies past Saturn in 1980.
- U.S. launches first space shuttle Columbia in 1981, it makes 36 orbits.
- Computers become familiar sight in U.S. classroom—PC sales hit 1,000,000 mark in 1981.
- Hewlett-Packard superchip is first 32-bit microprocessor in 1981.
- Professor K. Kitazawa of the University of Tokyo reached zero resistivity in the field of superconductivity. In January 1987, Professor M. K. Wo of the University of Alabama in Huntsville and Professor C. W. Chu of the University of Houston made a world-famous breakthrough and achieved superconductivity at 98 degrees kelvin. It is now being achieved at 125 degrees kelvin.
- The Boeing Company successfully completed a 30-day state acceptance test of the Alabama Supercomputer Network on March 1, 1988. The CRAY X-MP/24 central processor is capable of performing 400,000,000 calculations per second—making it one of the fastest computers in the world.

Political Element

The political element during this period revolved on domestic policy, consumer advocacy programs, defense spending, foreign affairs, and a non-war war that nobody won. International tensions were high, terrorism took on new meaning, and presidential cover-up led to resignation.

The theme of Nixon's inaugural address on January 20, 1969, was a focus on unity because he had inherited a country involved in a non-war war and beset with occasions of unrest. He tried to reduce U.S. involvement in Viet Nam, visited China in February 1972, continued the process of school desegregation, and fought unemployment.

The Nixon-Agnew ticket swept to an easy victory in 1972 largely on Nixon's reduction of the Viet Nam conflict. Some nine months later on October 10, 1973, Vice President Agnew resigned following a plea of *no contest* to an income tax evasion charge. On August 8, 1974, President Nixon announced his resignation effective at noon the following day under the threat of impeachment over the Watergate Affair.

Gerald Ford replaced Agnew as Vice President Agnew under a provision of the 25th Amendment of the U.S. Constitution. He was sworn in as Vice President on December 6, 1973. Ford was sworn in as President on August 9, 1974 following Nixon's resignation. Ford's major challenge of the moment was to restore national confidence in executive leadership and in the institution of government. He implemented an open administration and acted with candor. His approach seemed to be working until the day—September 8, 1974—that he granted former President Nixon a "... full, free and absolute pardon. . ." The response from all quarters was overwhelmingly negative. The Viet Nam War ended in 1975, but trouble continued in the Middle East. The U.S. celebrated its bicentennial in style in 1976.

Although he fought a hard campaign and most voter's admired his honesty, Ford lost in his bid for reelection to Jimmy Carter.

Jimmy Carter was inaugurated on January 20, 1977. In the area of foreign affairs, President Carter sought to establish human rights as fundamental to U.S. policy. He took a strong position in the international arena when he advised the world that "if Russia does not withdraw its troops from Afghanistan, we, the United States, will boycott the 1980 olympic games." Russia didn't and we did. He signed the Strategic Arms Limitation (Salt II) Treaty with Soviet President Leonid Brezhnev in Vienna in June 1979.

National defense was of continuing concern and a most difficult problem confronted Carter in November 1979 when radical Iranian students seized the American Embassy in Teheran and held diplomats and employees hostage for 444 days. It is perhaps ironic that the hostages were released on January 20, 1981, the day of the inauguration of the man that beat Carter at the polls—Ronald Reagan.

Ronald Reagan became one of the most popular U.S. presidents of all times. He pledged to reduce national government, return power to state governments, reduce government spending, expand our defensive capabilities and capacities, reduce taxes, and strive for a more peaceful solution to world tensions than detente.

President Reagan's first term was principally concerned with implementation of his economic program. *Reaganomics*—as it was labeled by the media—has had mixed results. Reagan's domestic focus in his second term was tax reform.

President Reagan took tough military stands in the international arena on several occasions. In October 1983, he ordered the invasion of Grenada—an island in the Caribbean—to protect U.S. citizens on the island and to blunt Cuban-Soviet aggression. Again in April 1986, he approved of an attack on *terrorist-related targets* in Tripoli and Benghazi, Libya. American war planes bombed strategic targets on April 14 losing only one F-111. The attack was in retaliation for Libyan-perpetrated terrorist attacks.

President Reagan's second term is winding to a close as this report is written. It appears certain that future historians will view the Reagan years as meaningful and influential.

During the 60s, 70s, and 80s, the U.S. passed significant legislation aimed at influencing social action. This included the Equal Pay Act of 1963, Title VII of the Civil Rights Act of 1964, the Age Discrimination in Employment Act of 1967, the Occupational Safety and Health Act of 1970, the Employee Retirement Income Security Act of 1974, and the Tax Reform Act of 1986.

Turbulence was spasmodic. The theme of reduced global tension seemed to work at times, but hot spots erupted periodically because we live in a world of many hostile emotions. The domestic theme was clearly one of human rights as agenda after agenda focused on social issues such as abortion and the right to life, prayer in public schools, school desegregation, overhaul of the civil service system, and welfare reforms.

Economic Factor

The economic factor witnessed recession, inflation, unemployment, and recovery. On October 19, 1987, Wall Street suffered its severest setback since 1929. Panic ensued, but certainly not to the level of 1929 and the economy withstood the strain.

The future economic growth of this nation rests on the development of a national strategic business plan much the same as is formulated by most major business organizations. It must tie world conditions, competitive factors, domestic and foreign policy, postulated technological advances, and U.S. objectives together in an integrated and systemic approach. This nation must take advantage of our extensive technological framework and make it the foundation of a sound economy.

Corporate America began to refocus after ignoring the Japanese challenge for the loyalty of the American consumer as long as it could. In commenting on the subject, T. Boone Pickens, General Partner of Mesa Limited Partnership and known by the media as a *corporate raider*, told the Economic Club of Detroit on May 2, 1988, that the problem began right after World War II when managers began minimizing risk and maximizing the upside. Pickens pointed out that managers forgot who they were working for and ". . . minimized their own risk and maximized their four Ps—Pay, Perks, Power, and Prestige—instead of maximizing value for the stockholders." It is Pickens's view that stockholders are beginning to make the difference and are forcing restructuring of corporations.

Productivity continues to be a source of concern for corporate America. At all levels of the organization—blue collar and white collar productivity trends and

gains are unstable as evidenced by the data in the opening chapter of this report. Commitment to quality, to the company that employs them, and to work itself is at issue for American workers and American management. This country clearly is not working at the level of competence it once did.

Social Element

The social element of our culture moved in the direction of civil liberty for all and for increased industrial democracy. Our views of working are increasingly influenced by gender with more females in the labor force, by age with more young unemployed and by a growing number of retirees that seek and secure a second career, and by educational level due to the increasing number of better educated employees.

Robert B. Horton, Managing Director and Chairman of the Board, BP America put the social challenge well in a baccalaureate address on May 16, 1988 at Case Western Reserve University in Cleveland when he said:

Good work separates humankind from the beasts. Ants farm, delve and make war, but they do not think, talk or laugh. Science has now decided that chimpanzees think. Myna birds talk. Hyenas talk. But when human beings work well, we do it while thinking, talking, and laughing. Good human work puts it all together.

Life appears more complex than in any previous age. There are more options, more temptations, greater mobility, increased independence, and more leisure time than in any past civilization. Coupled with these factors are a shrinking global environment, increased competition for scarce resources, growing concern for environmental factors, and a rapidly growing world population. These situations call for fresh solutions and an ascendancy in cooperative ventures.

The Advanced Technological Society

The advanced technological society offers the promise of challenge, self-fulfilment, and an environment that will encourage creativity and innovation. This great nation has proven its worth, its firm belief in the inalienable rights of human beings, and its compassion for neighbor on countless occasions. It has also demonstrated a firm resolve to back its beliefs with force and national determination when conditions warrant.

The Systems Era and rapidly evolving technology place urgent pressures on our American culture and our American spirit. Productivity perhaps does not hold the position of supremacy it once did, but it is productivity that leads to greater competitiveness, lower costs, market expansions, higher salaries, increased output, and improved quality. The quest for order, knowledge, and happiness continues in the enduring dream, for the present is fused with the past.

Chapter 8

Conclusions

For the rest of this century—and far into the next one—the competitive battle will be won or lost by white collar productivity.

Peter Drucker

This report has searched pertinent historical corridors for clues to the effects of historical cultural changes on present-day knowledge worker productivity. The search began with the earliest recorded history of civilization and ends today—a journey of approximately 5,500 years. The search was enjoyable and hopefully enlightening for it is necessary now to synthesize our findings.

Man's individual memories are only from childhood and he has no memories before then. But it is memory that stores our cultural heritage and that helps form our changes to that heritage. The intensity of our absorption with history and the written word then is explained by our personal lack of recollection prior to childhood and our need to understand the past as prologue to the future.

American culture is rooted primarily in Western Europe and Great Britain prior to colonization. Long term effects began developing from the dawn of recorded history, but not all aspects trace that far. Progress and cultural changes are usually made through exploration of alternatives. Some alternatives turn out to be detours that distract more than aid our progress, but all contribute in one way or another to our growing body of knowledge and to our long-term development.

The macro trends that follow are based directly on the research associated with this project and apply to our U.S. culture base. They are not founded on any particular theory of macro-history nor are they ordered in any sense of ordinal importance.

The macro trends are the same as appear in the Executive Summary at the beginning of this report. Each trend is followed by a brief discussion of its implications for management.

Macro Historical Cultural Changes

Culture can, will, and does change and is doing so at an increasing rate.

Cultural change can be evolutionary as exemplified by the gradual shift in the

work ethic or it can be revolutionary and change almost overnight as it did on December 7, 1941. The implication for management is clear—the organization culture can be changed. Figure 8-1 depicts a graphic illustration of the organization culture and its major elements. A systems model for induced organization culture change is depicted at Figure 8-2.

Increasingly our culture follows a fairly rigid pattern of education, working, and retirement.

Within this trend it appears that educational expectations are rising, continuing education for working adults is growing, and second and even third careers for individuals are not uncommon. The half life of an engineer's knowledge is five years and in ten years over three-quarters of what an engineer knows will be computer-related. Computer-based technology will greatly enhance the educational process and management must develop strong in-house programs or contract for continued education and training of employees.

The work ethic reconciles the antithesis between material happiness and religious worth.

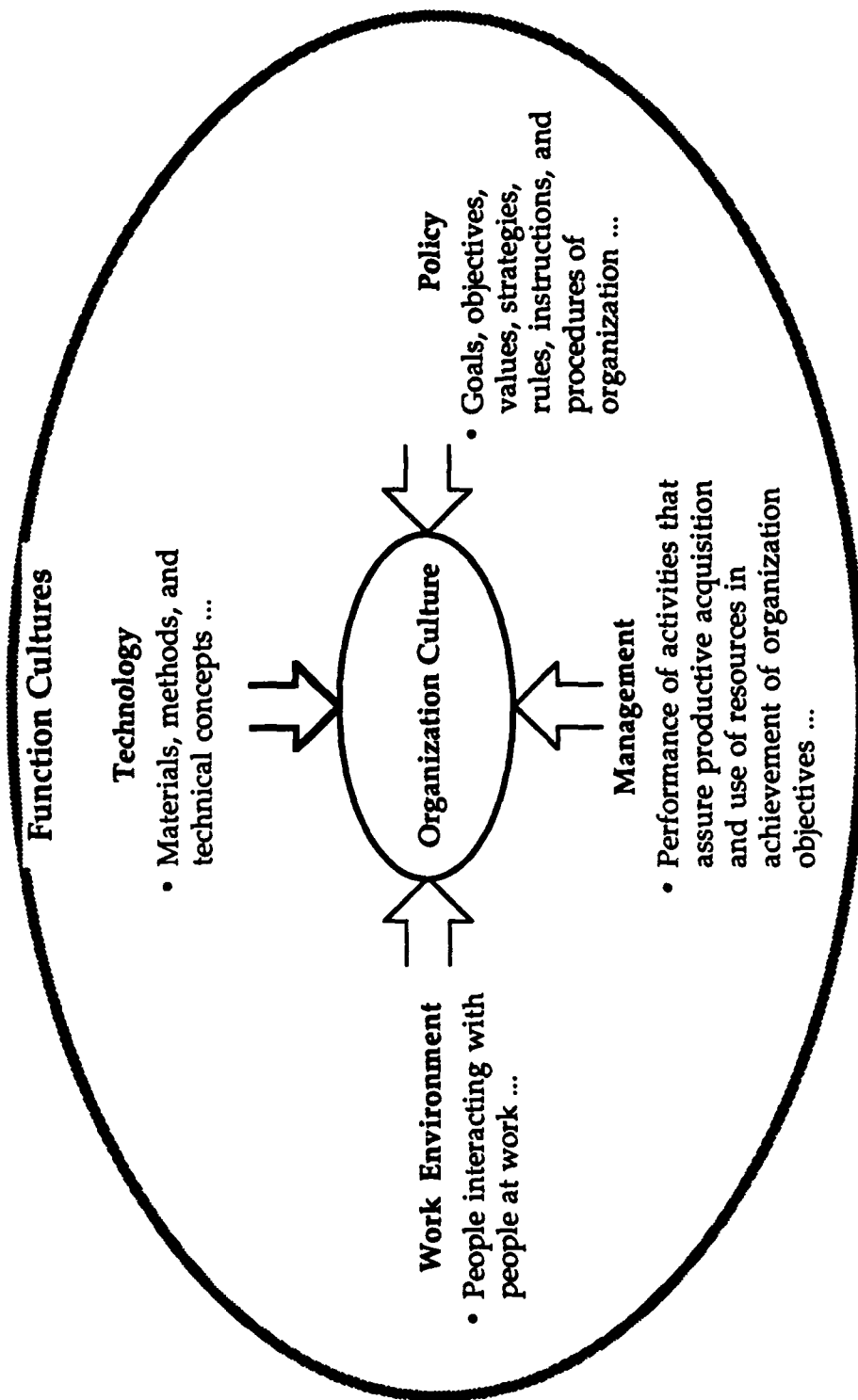
Indications are that the work ethic is alive and well, but employees are withholding *discretionary output* because they find no motivation to do more than the minimum required. This issue is central to improved productivity. Referred to as *latent ability* by James Lincoln, *work centrality* by the Meaning of Working (MOW) International Research Team, and *discretionary effort* by the Public Agency Foundaton, the idea of discretionary output by workers is now new or novel. It was witnessed perhaps in its most abundant form in the massive outpouring of materials and the self-sacrificing of World War II. All employees can do more—it is management's job to urge its cooperative offering by employees.

For Bonnie Blair—U.S. gold medalist in the 500 meter speed skating race at the 1988 Winter Olympics at Calgary—the difference between gold and silver was 2/100 of a second. Bonnie Blair put forth her discretionary output. For Sandy Lyle at the 52d Masters Golf Tournament at Augusta, GA in April of this year, a 7 stroke difference (a 2.4 percent difference in four rounds) meant an increase in prize money from \$28,000 for tenth place to \$183,000 for first place—an 800 percent improvement. Sandy Lyle put forth discretionary output because there was a direct correlation between output and reward.

The economic element of our ergonculture has moved from an agrarian-based to a capitalistic-based foundation with emphasis on the service sector and a decline of the manufacturing sector.

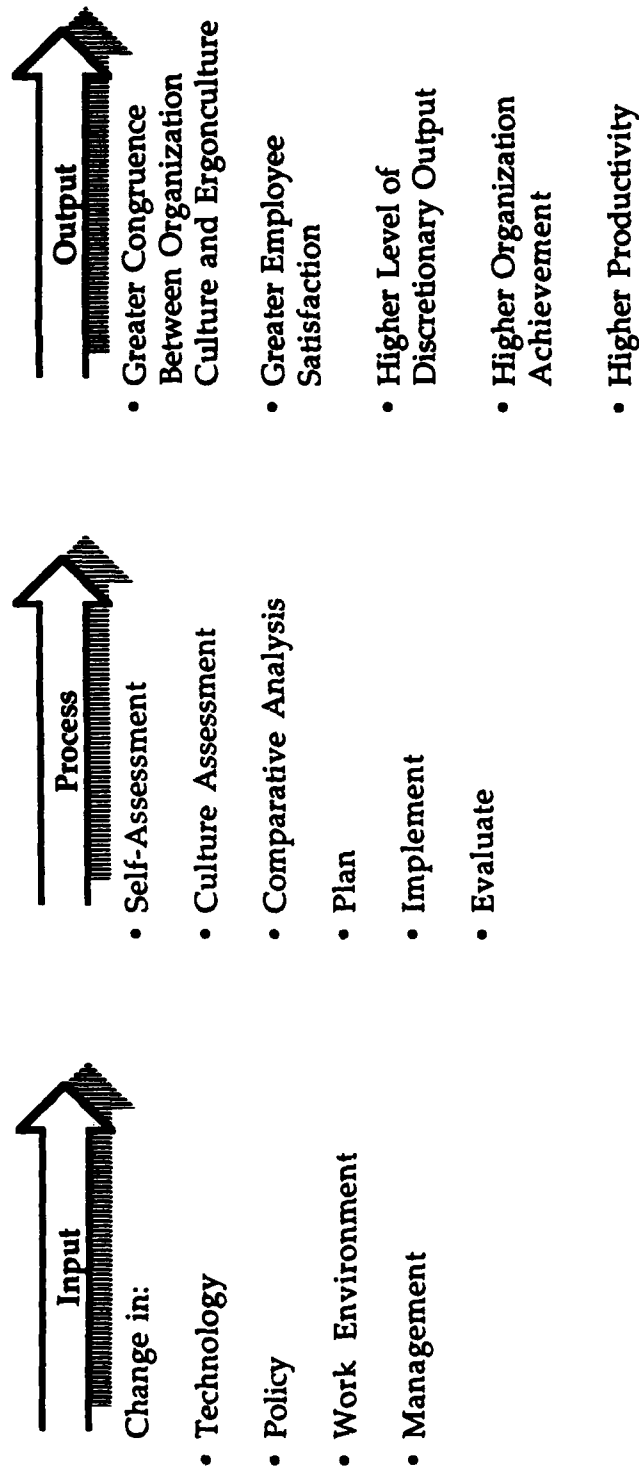
The implications for Government seem clear. The capitalistic nature of the economy must be nurtured and kept healthy. The Laissez-Faire approach of Adam

Figure 8-1 Organization Culture



The organization culture is indirectly constrained by function cultures such as the ergonculture, the consumer culture, the education culture, and the industry culture.

Figure 8-2 Induced Organization Culture Change From a Systems Perspective



Productivity is not a means, it is an end – the result of involved workers, knowing what is expected of them, provided with the tools and technology they require to get the job done, and given the opportunity to perform coupled with commensurate rewards.

Smith does not work in practice, but too much Government regulation will turn capitalism into socialism. Government action must check the excesses and harness the benefits of a capitalistic economy.

Our technology base is gaining mastery of matter and environment at an increasing rate.

Mr. Herman L. Matzet, retired, was born in Birmingham, AL on October 25, 1904. In just a month, Matty—as he is known by family and friends—will be 84 years young. Matty's father and mother immigrated to the U.S. from Germany before the turn of the century to seek the American dream. Young Matty—the youngest of nine children—grew up to become a professional baseball player and then turned to promotion of sporting events and other activities in the Cincinnati area.

During Matty's lifetime, he has witnessed:

- Practical application of the heavier-than-air flying machine.
- The replacement of horse and buggy by the automobile.
- The practical application of radio in commercial broadcasting.
- Two World Wars.
- The Roaring 20s.
- The Great Depression.
- Development and commercialization of television.
- Development of liquid-fueled rockets.
- Development of atomic power.
- Practical application of electronic data processing equipment.
- Man landing on the moon and returning safely to earth.
- Untold miracles in medicine and chemistry.
- Introduction of robots.
- Amazing strides in superconductivity.
- Consciousness in silicon.

Technology will continue to play an increasingly dominant role in our everyday and working lives, and is a powerful agent of improved productivity.

We hold dear the new state of human liberty proclaimed by the Declaration of Independence.

Patriotism may waiver, but American resolve will not. The liberty ethic created a fresh view of human relationships and today is the foundation for the industrial democracy movement. We must implement policies and practices that reinforce the liberty ethic and that integrate effectively with our cultural heritage—not another nation's heritage.

Women are playing an increasingly important role in ergonculture development.

It is estimated that approximately 63 percent of new entrants into the 1985 to 2000 workforce will be female. Bureau of labor statics indicate that female employees constituted 31.4 percent of the workforce in 1950 and almost 55 percent by 1986. By the year 2000, females will make up almost 60 percent of the labor force.

Managers must accommodate this change, provide equal pay structures for equal work, increasingly offer child-care programs, and develop new motivational strategies that will coax discretionary output from female as well as male employees.

Military offensive and defensive capabilities are increasing at an increasing rate.

Military preparedness will be the watchword for perhaps generations to come, but increasingly will be considered in trade-offs with social programs. The need for a balanced budget will cause trade-off analysis among all programs including the Space Program. Government managers will be forced to make up some cuts through increased productivity—getting the same output for less input.

The productivity triad is depicted by means of a Venn diagram at Figure 8-3. Maximum productivity improvements occur when all three elements of the triad interplay and create innovative synergy. Improvements may come in any set or subset, however, and is limited only by the limits of our own imaginations.

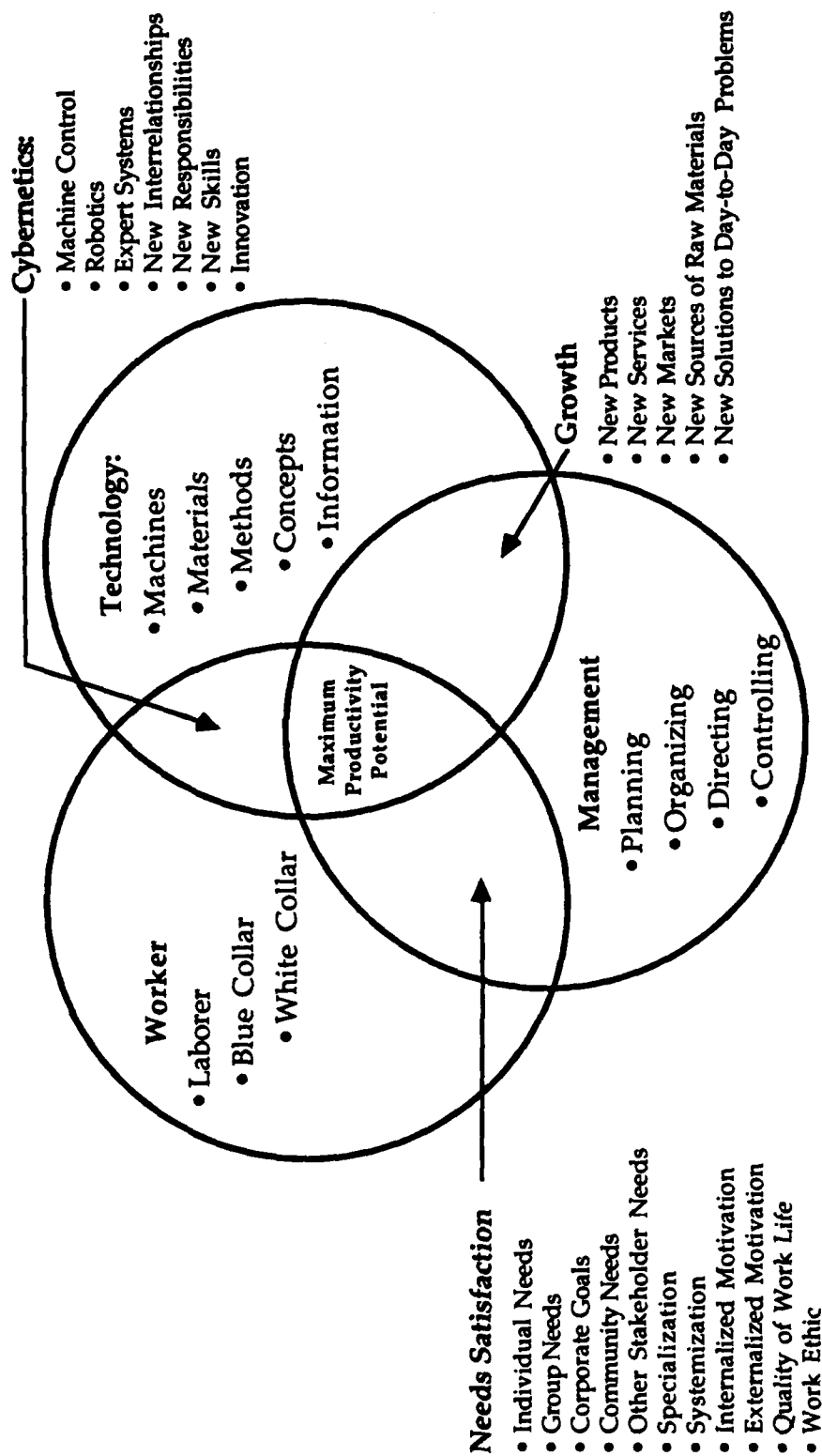
A simple systems model for inducing productivity improvements in an organization is depicted at Figure 8-4. This model does not include any attempts to influence cultural change—that model is discussed later in this chapter. The productivity improvement cycle is depicted at Figure 8-5.

There is an increase in literacy and in continuing education.

Education and training are central to improved productivity. Utilization of public school facilities will have to be broadened in order to maximize the utility of current investment. As new jobs are created by the automation revolution, training and retraining will be required to permit employees to keep pace. Proactive managers that look to the future in order to minimize problems and to capitalize on opportunities will be far more competitive than reactive managers that wait for something to happen. Expert systems will increasingly allow proactive managers to shape their tomorrows more to their liking and to their increased profitability and survival.

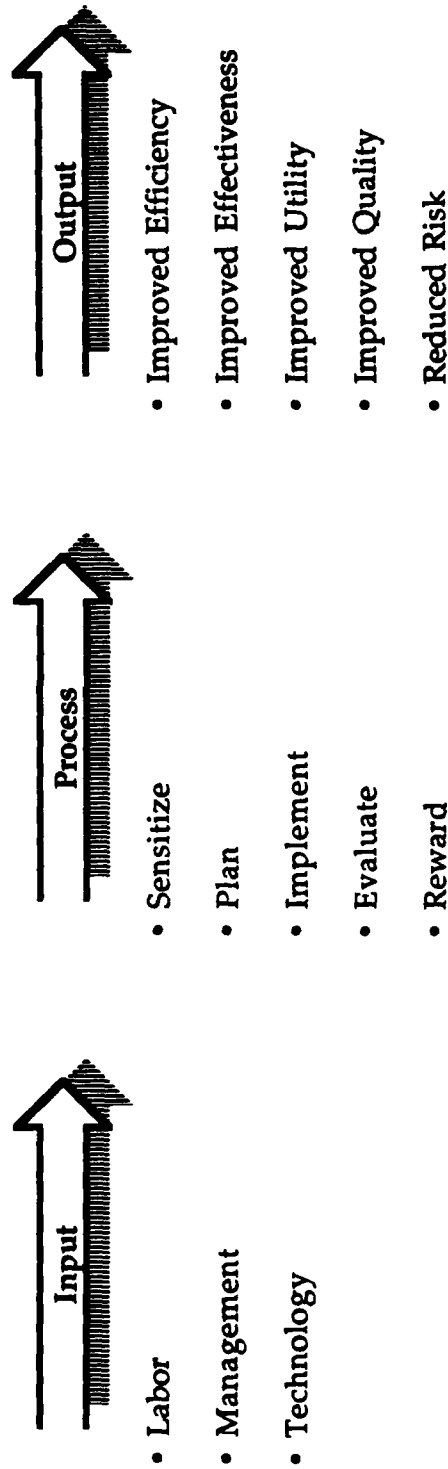
The educational system will advance rapidly with improved pedagogy and greater reliance on computer-based instruction such as simulation, computer-based self-pace programs, and more time devoted to literature research. Unconventional

Figure 8-3 Productivity Triad



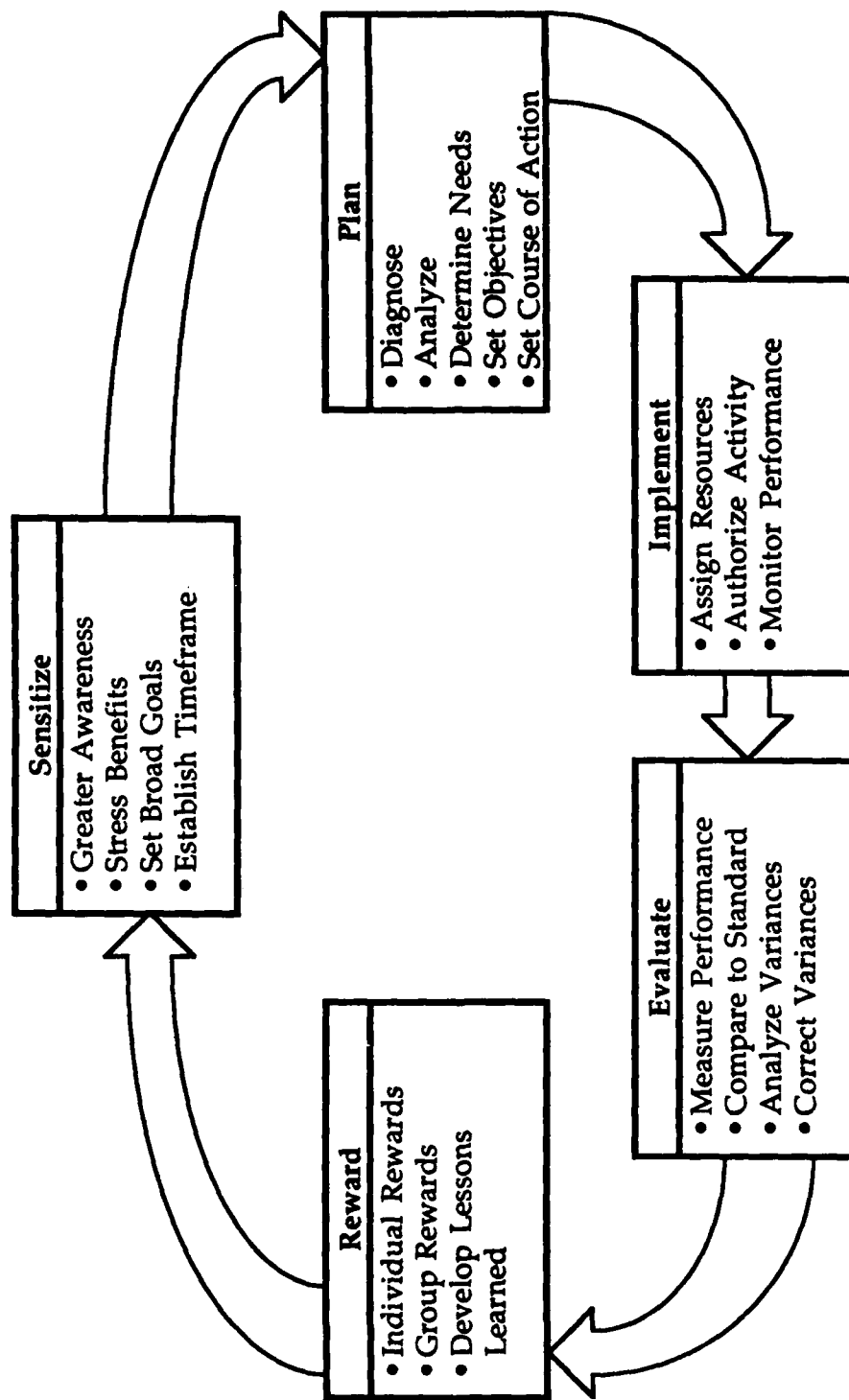
Maximum productivity potential occurs in the synergistic interaction of motivated workers, applied technology, and committed management.

Figure 8-4 Induced Productivity Improvement From a Systems Perspective



The catalyst for white collar productivity assessment is increasing competition and the uncertainties of transition into the automation revolution.

Figure 8-5 Productivity Improvement Cycle



Productivity improvement is an interactive process.

techniques such as sleep learning and mental practice of motor skills will mature as techniques.

Affluence and leisure time are increasing.

Management must learn to cope with this cultural change and harness it as a motivational tool. Greater affluence may mean less motivation through material rewards, but may mean more motivation through other incentives that reward individuals that regularly put forth added discretionary output. A close and highly visible link between performance and reward must be established. Encouragement of self-development, added prestige, and other perks will be necessary. It also may be necessary to reconsider the impact of tenure systems on productivity and rethink their strategic and bureaucratic utility.

Heroes are critical.

A colleague said recently: "We don't have any heroes in America anymore—we need heroes." He was correct. The heroes of the American revolution, industrialization, World War I, the Roaring 20s, World War II, the Space Age, the All-American Boy sports heroes are fading from view. We need heroes of productivity and a return to excellence in working life.

Writing about the 1988 Summer Olympics in Seoul, South Korea in the September 19, 1988 issue of *Time*, Tom Callahan said: "The image of excellence steadily changes, but the impression of it is always the same (stirring, stunning, surprising), and just the fact of it is reassuring." The message applies equally to any endeavor—particularly government and industry.

We are moving increasingly from a revealed truth base to a reason-based foundation.

The Protestant Ethic broke the chains that bound man to existing ideals of religious worth. As we progress we are becoming more quantitative and our culture more based on reason than divine guidance. This translates to a requirement for management to involve employees more in the decision making process and to provide greater explanation for actions taken than ever before. This turning toward secular ideals is also reflected in religious movements that are trending toward more pragmatic and worldly views than before. The Vatican II council in the Catholic Church is perhaps as indicative of this movement as any. Changes of this nature tend to be very slow and affect details of the culture for longer periods of time.

Political power is increasingly centralized and concentrated.

While politicians argue federal control vs. state control, the control of individual and corporate entities continues to grow more restrictive. The trend under the

Reagan Administration was less Federal Government—more State Government. How that trend will change—if it does change—under the next administration is hard to tell. Some forecasts call for less government in business through deregulation and changes in antitrust laws.

Information processing is playing an increasingly important role in development of our ergonculture at an increasing rate.

There has been a significant increase in the knowledge-related industries over the past several decades. We are truly becoming an informaton-dependent society and information leads to knowledge which is power. Traditional chains-of-command in some sectors are giving way to knowledge-based structures requiring new organizational controls and innovative motivational techniques. Expert systems are becoming more common and it is estimated that investment in expert systems and associated technology will exceed \$1B this year.

The information explosion is enabling a rapid growth of new products and greater competition. These conditions will facilitate improved productivity when properly hardnessed by management. This specific area—in all of its broader aspects—represents a most furtile area for productivity improvements.

U.S. culture is becoming more homogenous while at the same time fostering diversity as an explicit value.

Our culture is becoming more homogenous because of exposure to our external environment. We generally see the same television shows, read the same newspapers, receive the same education, and go through the same training programs. Marriages between individuals of different faiths, ethic groups, and geographical locations also tend to blend cultural backgrounds into a more homogenous pattern. In other words, there is a leveling occurring that makes our national culture more cohesive.

At the same time, our culture is becoming more receptive to background differences and objects less than it did to displays of varying cultural heritages.

These countervailing forces must be understood in the workplace and woven into the motivational fabric of the organization. To do so will require creativity on the part of management, but basic human values and aspirations of success will be the focus of motivation techniques that will lead to a cooperative sharing of discretionary output by employees.

The entrepreneurial spirit is on the ascendancy.

The number of self-employed individuals grew 24 percent from 1974 to 1984 and is increasing at a rate four times greater than the rate of salaried employees. In the

20-year period from 1950 to 1970, the number of new businesses founded increased from just under 100,000 to in excess of 300,000 annually and hit 600,000 in 1984. Small businesses are numerous in the U.S. and account for the majority of employment of the U.S. labor force.

The entrepreneurial spirit is associated with risk taking and total commitment. If there is one element in the ergonculture that one would believe intuitively is regularly putting forth close to maximum effort—putting forth that discretionary output that is typically held back—it is the group of entrepreneurs in this country that own and manage tightly-controlled small businesses. Why? Because there is no one else to do the job that has to be done to allow the company to survive. The entrepreneur accepts the risks of business as a given. In exchange for hard work and self-sacrifice, the entrepreneur hopes to offset the risk by sufficient financial and personal satisfaction to make the venture worthwhile.

The entrepreneur sees a direct relationship between effort and reward. In theory, hard work and the entrepreneur's business acumen should be related to such indicators as gross sales, return-on-investment, and profit margin. When the relationships are out of balance, the entrepreneur must move to restore balance for their is no one else to do it.

When the entrepreneurial spirit can be instilled in employees, productivity should increase and management holds the key that will unlock the cooperative outpouring of discretionary output by employees.

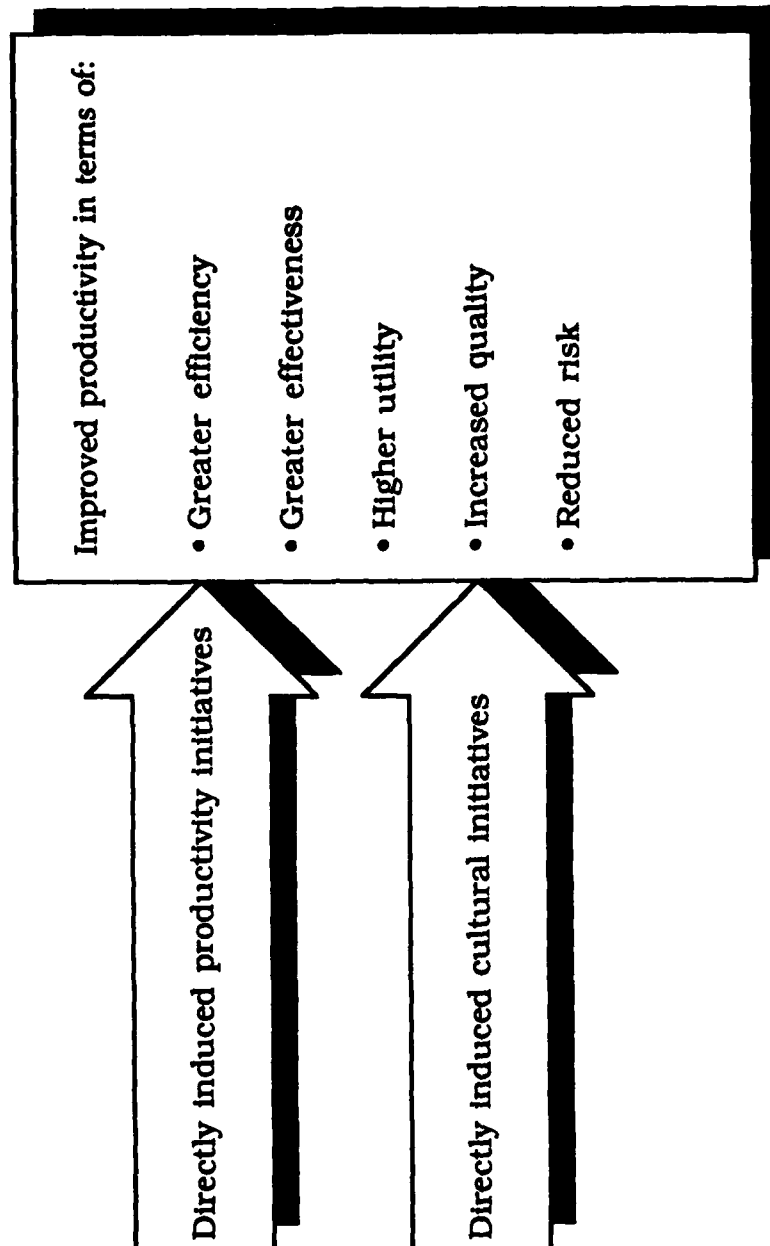
A Managerial Framework

There is no universal, sure-fire, instant solution to the prickly issues of the productivity concern. We collectively thought—for awhile—that it was *Japanese management* with all of its trappings, but it wasn't. Many thought that it might be Ouchi's *Theory Z* with its tailored—not mimicked—Japanese approach, but it wasn't. There is no universal, one-shot, quick-fix. People differ. Some work to survive, some to advance and raise their standard of living, and some to be all that they can be.

The world of working is man made. Man is active and is both defined by and defines his environment. The corporate culture affects the world of working for its membership, but the members affect the organization and its culture in matters of cooperation, productivity, involvement in constructive and destructive conflict, acceptance or rejection of cultural norms, and in their basic decision to put forth or withhold discretionary output and energy.

Two major paths to productivity concerns exist as depicted at Figure 8-6. Directly induced productivity initiatives consist of such activities as cost reductions,

Figure 8-6 Induced Change



The use of directly induced cultural change as a source of productivity improvement is often neglected.

streamlining, suggestion programs, quality circles, and other productivity-specific improvement thrusts. These techniques typically follow a macro approach at the plant level or a micro approach that focuses attention at the individual level. When effective, these types of initiatives normally precipitate quick results and the productivity improvements are real. They may, however, leave employees culturally unchanged and still withholding their discretionary output. In other words, the action neither increases the employee's basic job satisfaction nor the importance of working in his life.

The second major path in Figure 8-6—directly induced cultural change—may take longer for initial results to emerge, but the overall effect should be more meaningful. This thrust suggests that the path to productivity will be found in concentrating on corporate culture from a systemic view for enrichment as this level of concern leads naturally to improved productivity. Equally important, the improvement occurs because the employees *want* it to occur. A systemic model of this concept of organizational culture is depicted at Figure 8-7. The culture creates the environment that guides human behavior and aligns employee goals and objectives with corporate goals and objectives. It becomes or is the implementation of Taylor's concept of *mental revolution* both in spirit and intent. A strong and highly visible culture then serves as the framework of reference for performance that either demonstrates compliance with or deviation from established norms. Feedback is inherent, systemic, and evocative.

Just as energy sources fuel the engines of power that do physical work, human energy fuels the engines of organization that convert customer requirements into deliverables. People are the bridge between culture and productivity and maximum gains are achieved through the synergy that occurs in the dynamic interaction of technology, management, and employee. This relationship is depicted graphically at Figure 8-8.

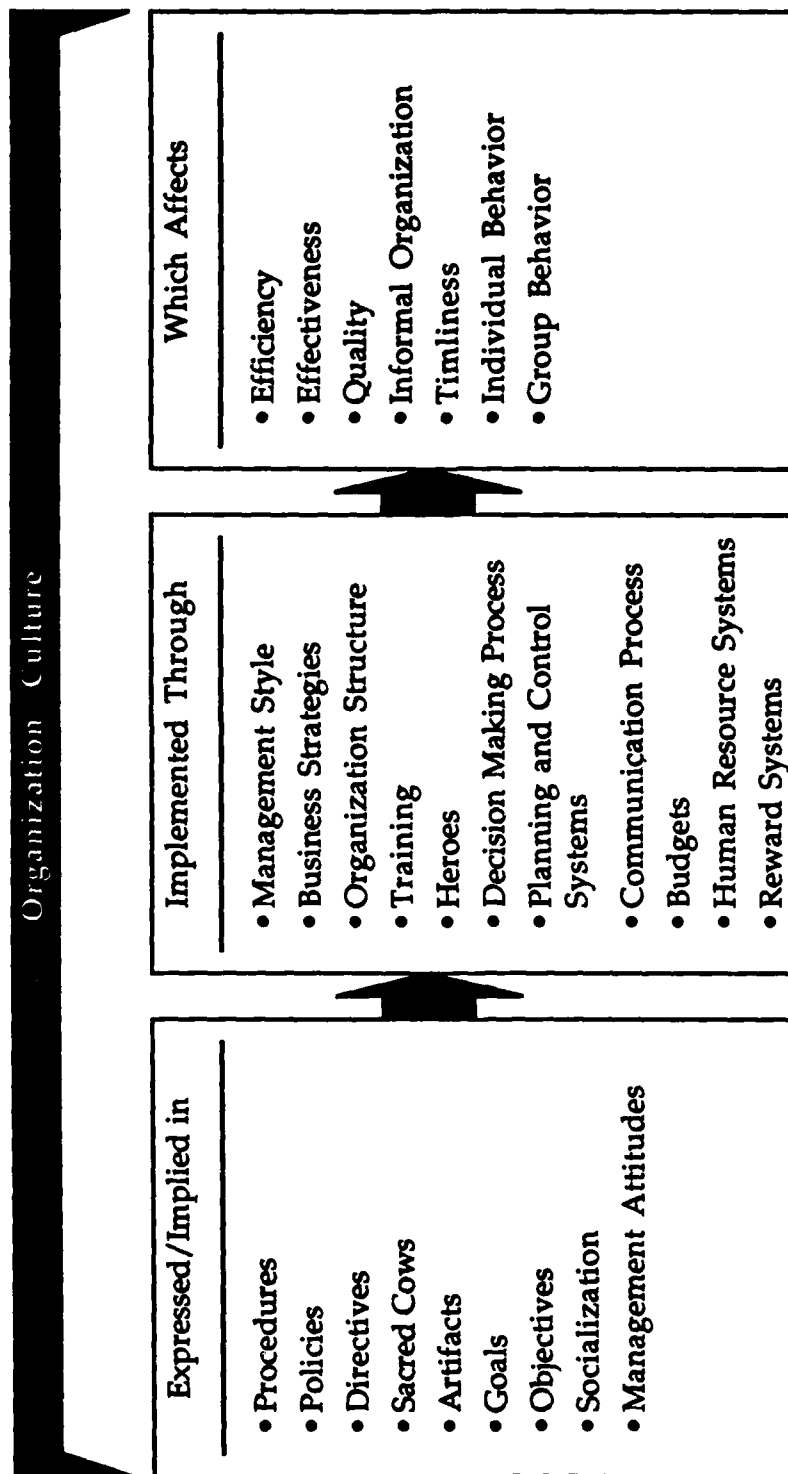
Managerial actions that should serve to enhance organizational culture follow.

Establish clear vision of mission—Every organizational element should have a clear view of its mission. A descriptive mission statement provides identity for the group, establishes the framework for organizational activities, and provides understanding for interrelationships with other organizations.

Develop a service focus—Knowledge work is frequently service oriented. A service focus must be established and maintained whether actual and target customers are internal or external to the organizational context. Performance measurement should be directed toward customer satisfaction.

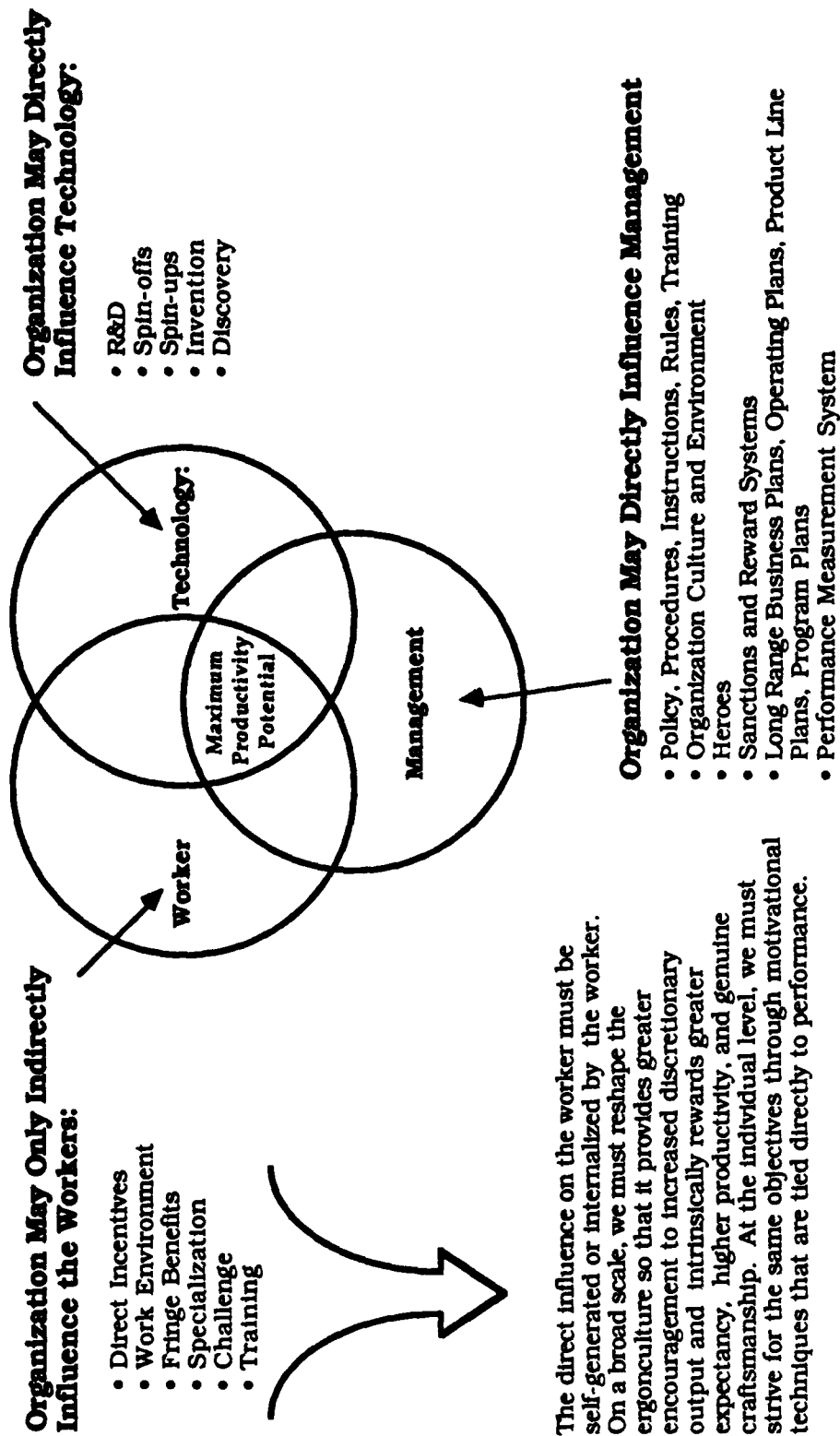
Define expectations—Management must define its expectations of employees in terms of mission accomplishment and how those expectations are measured. Expectations must balance the fine distinction between *stretching* employee

Figure 8-7 The Culture - Performance Relationship



The organization culture is a powerful influence on business results.

Figure 8-8 Culture-Productivity Bridge



People are the bridge between culture and productivity.

potential and being achievable. As a general rule, we tend to underestimate our own capacity. On the positive side, however, we tend to try to measure up to the expectations of others that are significant in our lives. This is true between athlete and coach, student and teacher, child and parent, and can be true between employee and management. The sociotechnical approach provides a framework for this concept of expectancy.

Provide the tools, resources, and environment—Even the most motivated of employees and the best of craftsmen need tools and other resources to get the job done. Employees should understand that management will provide necessary resources be they increased automation, software programs, computing capacity, electronic desk-top publishing capability, or office equipment. This element also includes corporate intensity and support and creation of an environment or culture that provides for sustained professional growth and development. Nothing destroys momentum and spirit faster than corporate management level indecision and constant challenging of program objectives.

Challenge employees—Employees should be challenged professionally so that they feel a sense of accomplishment with successful achievement of objectives. The key here is to seek and obtain employee commitment because performance will not include any measure of discretionary output or energy without commitment. Employees must buy-in and willingly increase the level of discretionary output that they add to performance in order to move the organization forward. Such commitment cannot be assumed or taken for granted; it must be earnestly sought by management and continuously nurtured when secured. It must also help employees increase their own self-awareness so that they better understand their role and the importance of their contribution. Commitment on the part of employees provides a margin in program execution that is difficult at best to attain in any other manner. In a competitive environment it may provide the edge needed to be a winner.

Link rewards with performance—This element is tied to the previous element. Employees must be able—as discussed earlier—to tie performance to reward. Tsviet, in a recent article, points out that "Annual gains of five to ten percent are easy, and one time gains of 65 percent are always at hand if we employ logic and nurture a climate conducive to the total culture of productivity." Reward for performance is a critical element of a successful corporate culture. Mediocrity cannot be rewarded at the same level as excellence.

Allow breathing room—Managers of knowledge workers must allow them breathing room. The management by objectives philosophy offers an excellent conceptual model. To the degree possible consistent with corporate policy, employees are allowed considerable latitude to determine means and methods while being held accountable and responsible for ends and results. Emphasis is on meeting program targets and objectives and full development of personal and group

competencies. Measurement of performance focuses on services rather than on activities and are used for coaching rather than monitoring.

Make it happen—The reactive manager says "have a nice day" while the proactive manager says "make it a nice day"—a small difference in wording, but a critical difference in outlook and philosophy. The word *have* suggests a reactive, cope the best you can with what comes approach. The word *make* suggests a proactive approach that underscores a philosophy that understands that managers can change tomorrow—even if ever so slightly—with a proactive approach today. A search of tomorrow for potential problems and budding opportunities pays dividends—it makes tomorrow a closer construct of what you want it to be. It moves the odds more in your favor, reduces your risk, and may be the 2/100 of a second you need over your competition in the drive for the gold.

The Challenge

Knowledge worker productivity is a concern of national proportions and cultural change holds the key to meaningful and sustained long term gains. The U.S., unfortunately, seems to have a growing national impatience and progressively focuses on near-term gain. This impatience must be checked because induced cultural change probably will not result in over-night results and should not be pursued with that goal in mind.

There is growing evidence to support the conviction that substantial gains are possible. Few organizations, however, have developed well organized, integrated long-range strategies. Even fewer, in all probability, are attacking the productivity issue on the cultural front.

Thomas Edison once said "I never did anything worthwhile by accident." While this comment does eliminate serendipity as a phenomenon, it underscores the need for planned action.

In a poll taken several years ago by the Japanese Department of Statistics and Information of the Ministry of Health and Welfare, workers were asked to establish their priorities in an unusual manner. They were asked a question phrased generally as: "If you were on your way to work, and an earthquake erupted, and you could only make one telephone call, who would you phone—your wife or husband, your physician, your children, your employer, or your parents?" The overwhelming response by the majority of those so queried was *employer*. This author is not suggesting that the American response is or should be the same, but it does place one element of the competition in perspective.

What is needed are the proper motivational techniques that will cause knowledge workers to want to risk everything in order to found their own business.

This induced cultural change will ensure that employees willingly offer added measures of their discretionary output. This research has shown—if nothing else—that it is a historical fact that entrepreneurship is a compelling force for commitment in business.

The ball is in management's court—make it happen!

. . . the good shepherd lays down his life for the sheep. The hired hand, who is no shepherd nor owner of the sheep, catches sight of the wolf coming and runs away, leaving the sheep to be snatched and scattered by the wolf. That is because he works for pay; he has no concern for the sheep.

John 10/11-13

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Appendix A

Author's Resume

William C. Wall, Jr.
3611 Memorial Parkway, SW
Huntsville, Alabama 35801
(205) 882-3238

PERSONAL QUALIFICATIONS STATEMENT
10/88 Update

PROFESSIONAL:

1991 - Present - As described in basic resume plus 1985 to Present update:

BATTELLE (1 contract):

- Conducted an independent technical review (ITR) of the U.S. Army Strategic Defense Command (USASDC) Braduskill Interceptor Concept (BIC) Project to assess technical approach, system effectiveness and vulnerability, program risk, internal and external technical and programmatic interfaces, and adequacy of planning activity and program schedule.
- Developed an interim source selection cost realism evaluation methodology for the Terminal Imaging Radar (TIR) Project Office. Briefed the methodology to Project Office personnel and provided draft input to the TIR Source Selection Evaluation Plan. Content focused on the interrelationships of the project manager's estimate (PME), the independent cost estimate (ICE), the spreadsheet format, the pricing analysis, and the quantitative and qualitative analysis.
- Developed and defined a methodology for conducting a cost realism analysis in a source selection environment. Study addresses cost estimating methodologies, cost estimating in the project environment, an examination of the USASDC approved cost model and its use in source selection, the interaction between engineering cost estimating and parametrically derived cost estimates using computer-based models, and bridging methodologies for crosswalk between engineering and parametric estimates.

The BDM Corporation (4 contracts):

- Participated in the development of the Second Source Acquisition Plan for the Stinger Project Office, U.S. Army Missile Command, (USAMICOM). Specific inputs included development of analysis logic, examination of motivational incentives, construction of productivity factors, development of market survey methodology, and participation in report preparation and briefings to customer.
- Participated in the development of the Second Source Acquisition Plan for the MLRS Project Office, USAMICOM. Participation identical to that in Stinger.
- Member of Red Team and writer for Production Engineering Support Contract proposal for USAMICOM.

- Consultant to proposal manager and writer for both management technical volumes for Marshall Space Flight Center (MSFC), NASA, Safety, Reliability, Maintainability, and Quality Assurance Support Contract proposal.

Applied Research Inc. (1 contract):

- Participated as member of USASDC Cost Analysis Methodology Assessment Committee. Specific inputs included development of assessment logic, matrix and project organizational analysis, development of parametric cost estimate historical and estimated cost database management logic, and participation in report preparation.

The University of Alabama in Huntsville (3 contracts):

- Presented 3-day Project Management Seminar to MFSC, NASA, project office and laboratory personnel.

Boeing Military Airplane Company (BMAC) (1 contract):

- Developed methodology for formulating and implementing near term, midrange, and long range organizational strategies for High Technology Diversified Products organization.
- Developed quantified methodology for locating, cultivating, evaluation, and tracking new business opportunities for Simulation and Training Systems organization.
- Developed computer-based proposal preparation support system including establishment of system requirements and logic, designation of computer systems, acquisition of computer systems, construction of database, and implementation of Phase I.
- Served as Volume Manager for Executive Summary and Management Volumes for the Reconnaissance, Attack, Fighter Training System (RAFTS) proposal. Also served as major author of both volumes.
- Served as Volume Manager and sole author for the Executive Summary and as a major author for the Management Volume for the C-17 Aircrew Training System (ATS) proposal.
- Served as Volume Manager and sole author for the Executive Summary and as a major author for the Management Volume for the V-22 Operational Flight Trainer (OFT) and Aircraft Systems Trainer (AST) proposal.
- Served as Volume Manager for the Training System Book of the Technical Volume for the Long Range Air Antisubmarine warfare Capability Aircraft (LRAACA) proposal
- Developing and authoring the Advanced Facility Intrusion Detection System (AFIDS) Program Summary and Status Report (PSSR) that defines the program, specifies the program manager's work assignment and reporting requirements for matrix participants, and assesses status weekly. The AFIDS PSSR will serve as the baseline for reporting to senior management and the customer, and for the AFIDS Control Room.

Hilton Systems, Inc. (1 contract):

- Participated in providing guidance and technical advice to customer participating in USASDC Ground Based Laser experiment and competitive source selection.

TEACHING

Taught doctorate level course on the "Evolution of Management Thought" for Nova University, Fort Lauderdale, Florida, approximately 10 times nationwide.

PUBLICATIONS:

Two additional technical articles, one book, and four management guides.

WCW

William C. Wall, Jr.
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Huntsville, Alabama 35801
(205) 882-3238

PERSONAL QUALIFICATIONS STATEMENT

EDUCATION:

1978 Doctor of Philosophy, University of Oklahoma
Norman, Oklahoma

1975 Master of Business Administration, University of
Oklahoma, Norman, Oklahoma

1971 Master of Arts in Public Administration, University
of Oklahoma, Norman, Oklahoma

1953 Bachelor of Science in Mechanical Engineering,
Lafayette College, Easton, Pennsylvania

PROFESSIONAL:

1981 - Present - President, WCW Associates, Inc., Huntsville, Alabama. Serve as President and Chief Operating Official of the company responsible primarily for strategic planning and execution and for accomplishment and technical direction of engineering projects/subcontracts. Major engineering services projects/subcontracts of recent interest include participation in the comprehensive system engineering analysis for the Army involving the combat developer, the materiel developer, and the training developer, that identified the need for and established the cost-effectiveness of computer-based instruction in the HAWK weapon system and that generated the conceptual technical basis for the HAWK Institutional Training System (Raytheon subcontracts); participation in the engineering analysis conducted for United Space Boosters Inc. to determine the most cost-effective manner of refurbishing and assembling solid rocket boosters in the NASA Space Shuttle Program (BDM Corporation subcontracts); development of the SENTRY Project Office MIS development methodology and the SENTRY MIS Development Plan (Teledyne Brown Engineering subcontracts); determination of an appropriate and comprehensive set of engineering vectors for tracking system engineering performance of all US Army Missile Command weapon systems (approximately 45 systems) through all phases of weapon system life cycle to explain, control, and predict system engineering performance (Computer Sciences Corporation subcontract); development of comprehensive project management termination criteria and methodology for the Army (Sperry Corporation subcontract). Similar technical tasks also have been conducted in the past for Science Applications Inc., Harbridge House Inc., ANADAC Inc., and PRC Systems Services Company. Teach technically oriented management courses at the graduate level in an adjunct capacity at Nova University, The University of Alabama in Huntsville, and Florida Institute of Technology. Also have taught technical management courses to Department of Defense military and civilian personnel under direct contract with the Army.

William C. Wall, Jr.

PROFESSIONAL (CON'T)

1980 - 1981 - Deputy Project Manager, TOW Project Office, US Army Missile Command, Redstone Arsenal, Alabama. Shared with the Project Manager full responsibility for planning, implementing, and controlling the work and associated resources involved in providing the TOW Antiarmor Weapon System to using forces. Responsibility included all management and technical aspects of research, development, testing, procurement and production, distribution, and integrated logistics support. At that time the TOW Antiarmor Weapon System was in its basic configuration, and a second and third configuration were in production and development respectively. TOW was deployed in a ground mounted model, two major tracked vehicle models, and an airborne model. It was deployed with the US Marine Corps and more than 40 foreign military customers. Total budget in fiscal years 81 and 82 was approximately \$500 million each year.

1979 - 1980 - Chief of the Defense Advanced Research Projects Agency (DARPA) Projects Office, US Army Missile Laboratory, US Army Missile Command, Redstone Arsenal, Alabama, responsible for DARPA sponsored research projects assigned to the US Army Missile Command. Our range of interests included advanced strategic system concepts and technology, advanced surveillance systems, high energy lasers, strategic deterrents, strategic air vehicles, strategic early warning systems, space object imaging, tactical radar, advanced warheads, self-initiated anti-aircraft missile, forward looking infrared devices, sanctuary radar, and the National Training Center. Research programs were at the cutting edge of technology providing for discovery and innovative application of new technologies. The DARPA Projects Office was a small, highly skilled group of scientists and engineers involved in project management of approximately 100 active research projects amounting to approximately \$50 million annually.

1978 - 1979 - Deputy Project Manager, Ground Laser Designators Project Office, US Army Missile Research and Development Command, Redstone Arsenal, Alabama. Shared with the Project Manager full responsibility for planning, implementing and controlling the work and associated resources involved in providing ground laser designators to using forces. Responsibility included all management and technical aspects of research, development, testing, procurement and production, distribution, and integrated logistics support. At that time, ground laser designators were advanced systems requiring new and novel engineering and scientific concepts of rapidly advancing technology which were largely unproven and untried operationally. Management techniques employed had to be innovative providing the proper degree of structured control without unduly compromising technological considerations.

1976 - 1978 - Chief, Program Management Office, HAWK Project Office, US Army Missile Materiel Readiness Command, Redstone Arsenal, Alabama. Responsible for planning and controlling total weapon system program plans including costs and schedules, financial management and cost control, schedule control, and review and analysis. Functions included all weapon system activities from initial research, development, and test through acquisition, production, deployment, and logistical support. Programs involved US Army and US Marine Corps deployments, foreign military sales, and international co-production.

William C. Wall, Jr.

PROFESSIONAL (CON'T)

1968 - 1976 - Chief, Management Data Systems Office, US Army Ballistic Missile Defense Systems Command, Huntsville, Alabama. Directly responsible for development, implementation, and operation of the computer-based Management Information System, the Schedule Control System, and the Work Breakdown Structure; operation of the Command Computer Center and Technical Data Center; Government administration of weapon system contractor commercial automatic data processing equipment; and served as Director of Safeguard Management Information.

1957 - 1968 - Various positions in system engineering and technical program management at the US Army Missile Command, Redstone Arsenal, Alabama.

William C. Wall, Jr.

WCW

TEACHING ACTIVITIES:

1981 - Present - Professor of Management, National Graduate Faculty, and Director of Huntsville Center, Center for the Study of Administration, Nova University, Fort Lauderdale, Florida

1979 - Present - Part time faculty, The University of Alabama in Huntsville, Huntsville, Alabama

1978 - Present - Adjunct Professor of Management, Florida Institute of Technology, Melbourne, Florida

1982 - Present - Contract Instructor, US Army Management Engineering Training Activity, Rock Island, Illinois

PROFESSIONAL CERTIFICATION:

Certified Professional Estimator

PRESENTATIONS AND GUEST LECTURER:

Defense Weapon Systems Management Center, Wright-Patterson AFB, Ohio

Defense Systems Management College, Fort Belvoir, Virginia

The University of Oklahoma, Norman, Oklahoma

Department of Commerce, Washington, D.C.

The University of Alabama, Tuscaloosa, Alabama

HONORS:

Beta Gamma Sigma

Omicron Delta Epsilon

Senior Executive of the Year Honorable Mention - 1974

Outstanding Performance Awards, Department of Army - 1961, 1965, 1967, 1974, 1977, 1978, 1979

Department of Army Certificate of Merit - 1971

PROFESSIONAL SOCIETIES:

Project Management Institute

Academy of Management

Southern Management Association

Association of the United States Army

American Management Associations

National Estimating Society

American Association of Mechanical Engineers

CIVIC AND BUSINESS MEMBERSHIPS:

Huntsville - Madison County Chamber of Commerce

Better Business Bureau of North Alabama

National Eagle Scout Association

William C. Wall, Jr.

ATTACHMENT 1

PUBLICATIONS

Published

- Wall, William C., Jr. "Innovative Information Technology in City Administration." Oklahoma Business Bulletin (December 1971): 13-16.
- Wall, William C., Jr. Systems Management in the Urban Environment, Monograph 19, Norman, Oklahoma: Bureau for Business and Economic Research, University of Oklahoma, August 1973.
- Wall, William C., Jr. "An Analysis of Management Control in a Complex Large-Scale Endeavor: The Safeguard Ballistic Missile Defense System Program." Ph.d. Dissertation, University of Oklahoma, 1978.
- Wall, William C., Jr. "The Two-Tier Matrix Organization in Project Management." Defense Systems Management Review 1 (Autumn 1978): 37-46.
- Wall, William C., Jr. "The Prudent Use of Engineers in Program Management." Defense Management Journal 15 (March-April 1979): 14-18.
- Wall, William C., Jr. "Representation and Responsibility in a Tri-Service Program." Defense Systems Management Review 2 (Spring 1979): 30-33.
- Wall, William C., Jr., and Ross, Raymond R., II. "Reporting Missile Readiness." Army Logistician 11 (July-August 1979): 26-30.
- Wall, William C., Jr. "The General Manager of Matrix Organization." Defense Systems Management Review 3 (Spring 1980): 7-15.
- Meyer, Stewart C., and Wall, William C., Jr. "PERT in Ballistic Missile Defense (BMD)." Executive Commentary in Management: Making Organizations Perform, pp. 540-43. By H. R. Smith et.al. New York: Macmillan Company, 1980.
- Wall, William C., Jr., and Harris, William J. "Ground-Based Target Designators." Laser Focus 16 (June 1980): 75-79.
- Wall, William C., Jr., and Rosen, Leonard L. "What We Always Knew About Acquisition, But Were Afraid to Do." Defense Systems Management Review 3 (Summer 1980): 84-95.
- Wall, William C., Jr., and Stanbrough, David L. "MICOM Project Management Manpower Model." Concepts 3 (Autumn 1980): 7-19.

William C. Wall, Jr.

Wall, William C. Jr. "Managing in the Project Environment." Management of Optics. Proceedings - Society of Photo-Optical Instrumentation Engineers (SPIE), Huntsville Electro-Optical Technical Symposium, Vol. 260, pp. 24-28, Oct 1-2, 1980.

Wall, William C. Jr. Project Management: Theory, Tools, and Techniques. Huntsville, Alabama: Dominic's Press, 1981.

Wall, William C. Jr. "Ten Proverbs for Project Control." Research Management 25 (March 1982): 26-29.

Wall, William C. Jr., and Lollar, James L. Cost/Schedule Control Systems Criteria. Huntsville, Alabama: Dominic's Press, 1983.

Wall, William C. Jr. "Integrated Management in Matrix Organization." IEEE Transactions on Engineering Management. EM-31 (February 1984): 30-36.

Pinckley, Bennie: Wall, William C., Jr.; and Kirkland, J.D. "Integration - The Key to the HAWK Institutional Training System." Army R,D&A Magazine 26 (November-December 1985):9-11.

Wall, William C., Jr. Proposal Preparation Guide: The Systems Approach. Huntsville, Alabama: McMallec Publishing Company, 1986.

UNDER PREPARATION

"Managing in the Matrix Environment"

"Quantified Milestones and Their Use"

"Induced Conflict in Matrix Management"

"Project Management in Applied Research"

"Management Information Systems in Project Management"

"Termination Criteria and Methodology for Army Project Managed Systems"

"The Use of Expert Systems in Project Management"

"The Application of Computer-Based Instruction to Project Management Training"